REPORT RESUMES

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UNIVERSITY OF ILLINOIS SUMMER INSTITUTE FOR TEACHERS OF ORNAMENTAL HORTICULTURE IN THE MIDWESTERN SECTION OF THE UNITED STATES.

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DESCRIPTORS- *VOCATIONAL AGRICULTURE, *INSERVICE TEACHER EDUCATION, *ORNAMENTAL HORTICULTURE, *INSTRUCTIONAL MATERIALS, *INSTITUTES (TRAINING PROGRAMS), PROGRAM DEVELOPMENT, MATERIAL DEVELOPMENT, PROGRAM EVALUATION,

A RESEARCH AND DEVELOPMENT PROJECT, DESIGNED TO RETRAIN TEACHERS, DEVELOP ORNAMENTAL HORTICULTURE CURRICULUM MATERIALS, AND STIMULATE THE DEVELOPMENT OF VOCATIONAL ORNAMENTAL HORTICULTURE PROGRAMS IN THE MIDWESTERN UNITED STATES, INCLUDED TRAINING, SERVICE, AND EVALUATION ACTIVITIES. THIRTY TEACHERS SELECTED FROM 75 APPLICANTS ATTENDED A SUMMER INSTITUTE. EACH WAS ENROLLED IN TWO 4-WEEK COURSES, SPECIAL PROBLEMS IN HORTICULTURE AND WORKSHOP IN CURRICULUM DEVELOPMENT. THE GROUP PREPARED (1) 30 SOURCE UNITS ON PLANT PROPAGATION, FLOWERS AND FLORAL ARRANGEMENTS, GREENHOUSE, TURF, AND NURSERY MANAGEMENT, ARBORICULTURE, AND LANDSCAPING, (2) 50 LABORATORY EXERCISES, AND (3) AN EXPERIENCE PROGRAM PLANNING GUIDE, A RECORD BOOK, AND A NEWSLETTER. VARIOUS INSTRUMENTS WERE USED TO EVALUATE THE INSTITUTE PROGRAM, THE CURRICULUM MATERIALS, AND TO COLLECT AND SUMMARIZE DATA FROM THE SCHOOL PROGRAMS OF INSTITUTE PARTICIPANTS. OTHER EVALUATIONS WERE MADE DURING STAFF VISITS TO SCHOOLS, AND IN A FOLLOWUP MEETING FOR INSTITUTE PARTICIPANTS. THE PROJECT STAFF'S 15 CONCLUSIONS AND RECOMMENDATIONS INCLUDED (1) MULTISTATE INSTITUTES ARE EFFECTIVE MEANS OF BRINGING ABOUT CHANGE IN VOCATIONAL PROGRAMS, (2) A METHOD FOR SELECTING PARTICIPANTS WHO CAN DEVELOP NEW PROGRAMS SHOULD BE DEVELOPED, (3) TEACHERS SEEKING RETRAINING NEED A SPONSORED JOB INTERNSHIP IN HORTICULTURAL BUSINESSES, (4) THE COURSES IN THE INSTITUTE SHOULD BE MORE CLOSELY COORDINATED, (5) THERE WAS SUBSTANTIAL IMPROVEMENT IN THE PROGRAMS IN THE 28 SCHOOLS OF PARTICIPANTS, AND (6) TEACHERS FELT THAT THE STATE STAFF SHOULD PROVIDE MORE INSERVICE TEACHER EDUCATION, DEVELOP PRESERVICE TRAINING PROGRAMS FOR PROSPECTIVE TEACHERS, PREPARE CURRICULUM MATERIALS, AND HELP SELL PROGRAMS TO SCHOOLS, ADMINISTRATORS, AND TEACHERS. THE APPENDIX, THE MAJOR PART OF THE DOCUMENT, CONTAINS THE INSTRUCTIONAL MATERIALS AND EVALUATION AND REPORT FORMS. (JM)

FINAL REPORT
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UNIVERSITY OF ILLINOIS SUMMER INSTITUTE FOR TEACHERS OF ORNAMENTAL HORTICULTURE IN THE MIDWESTERN SECTION OF THE UNITED STATES

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**U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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Paul E. Hemp, Project Director

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The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

University of Illinois
Urbana, Illinois

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CHAPTER I

INTRODUCTION

The Vocational Education Act of 1963, Public Law 88-210, provided opportunities for schools to develop and offer new programs of vocational education not previously reimbursed under earlier vocational acts. Prior to 1963, the primary objective of most vocational agriculture programs offered through the nation's secondary schools was to prepare future farmers and to upgrade the proficiencies of present farmers. The changing needs of society and the technological revolution on farms in recent years have caused new demands to be placed on vocational education. Vocational education in agriculture has been redefined to include the off-farm occupations which require knowledges and skills in agriculture. One of the fields of agriculture which offers many employment opportunities is the field of ornamental horticulture.

Statement of the Problem

The central problem of this project was to promote the teaching of vocational ornamental horticulture in secondary and post-secondary schools of the midwestern section of the United States through a training institute and a curriculum development program.

Significance of the Problem

Prior to 1963, virtually no high schools in the Midwest were offering vocational education programs in ornamental horticulture. For example, in Illinois, there were no reimbursed programs in vocational ornamental horticulture at the secondary or post-secondary level until the 1965-66 school year. The development and growth of these new programs in most other midwestern states have been non-existent or extremely slow.

In large urban schools and suburban schools where vocational ornamental horticulture should thrive most vigorously there is usually no agriculture teacher to lead the way in program development. Teachers and administrators who do not have an agricultural background are often not aware of the growing need for trained workers in ornamental horticulture or else they still conceive of vocational agriculture in the narrow sense of training for farming.

Industry desperately needs and wants employees trained in greenhouse, nursery, turf, garden center, and landscape maintenance skills. Workers are needed at the skilled, technical, and managerial levels. Four-year colleges and universities are tooled up to provide professional training at the baccalaureate level or above. These institutions do not wish to start vocational programs for subprofessional workers.

The typical teacher of vocational agriculture in the midwestern states has not been prepared, either by experience or training, to teach ornamental horticulture. He is usually a farm-oriented teacher. Furthermore, most institutions which prepare teachers of vocational agriculture have not developed teacher education programs to prepare specialist teachers in ornamental horticulture.

In many states the area school is a new development on the educational scene, and the junior college movement is spreading rapidly. Vocational ornamental horticulture programs can meet many of the needs which such institutions are obligated to serve.

It is imperative that vocational ornamental horticulture be developed as a part of the nation's public school programs. Beautification of the nation's highways, grounds, and parks and the preparation of workers who can utilize the new knowledges and skills which are constantly flowing from experiment stations and research laboratories is a matter of great national concern. By the same token, it seems doubtful that we can ever achieve the American dream of developing each human being to his fullest potential until vocational curricula include a wide spectrum of programs which match the interests and capabilities of every segment of the population.

Purposes

The major purposes of this project were as follows:

1. To provide a group of 30 teachers with an intensive period of preparation in ornamental horticulture and curriculum development.
2. To assist institute participants in the development of teaching plans and instructional materials.
3. To prepare ornamental horticulture units and laboratory exercises for student use in schools of the Midwest.
4. To field test instructional materials and student materials in schools of the Midwest.
5. To follow up and evaluate ornamental horticulture programs conducted by teachers who participated in the summer institute.

The project was designed to include a training phase, a service phase, and an evaluation phase. The training phase was developed as a four-weeks, summer institute for 30 selected vocational teachers from the Midwest. The service phase was planned to produce curriculum materials for teachers and students to use on a trial basis The evaluation phase was designed to determine the effectiveness of the summer institute and the curriculum materials.

Research Related to the Problem

In most states of the Midwest, surveys have been conducted to determine the job opportunities in the field of agriculture and the knowledges and skills needed to perform these jobs. Usually, these surveys have shown that there is a growing demand for employees in nurseries, greenhouses, golf courses, parks, garden centers, and landscaping businesses. The demand for qualified workers is especially strong in suburban areas, areas near or in urban centers, and areas where personal incomes are high.

A review of certain social and economic trends also justifies the need for developing vocational education programs in ornamental horticulture. Some of these trends which have implications for the ornamental horticulture industry are as follows:

1. Population shifts in the Midwest have been from rural areas to urban and suburban areas. Residential building requires landscaping services and huge supplies of plant materials.

2. Americans are enjoying increased amounts of leisure time which is being used for golfing, gardening, and other activities closely related to the ornamental horticulture industry.

3. New interstate highways have been built and are planned for future construction. When federal funds are used to build highways, a certain percentage of these funds must be spent for beautification and landscaping.

4. Americans are becoming more interested in beautifying the countryside. More emphasis is being placed on improving the aesthetic aspects of the environment.

5. Many homeowners are employing service workers to maintain their lawns and plants. This is a part of the increased demand for service-type workers which has affected most occupational fields.

In the United States, homeowners spend approximately three billion dollars per year on lawns. There are more than 6,500 golf courses in the United States and the average annual expenditure for agricultural chemicals is $6,250 per course.

Ornamental horticulture is a thriving field of business in most midwestern states. More than a million rose bushes are sold in Minneapolis and St. Paul each year. Illinois ranks second among the 50 states in the sale of cut roses and first in the nation in the annual sales of deciduous shade trees. In Minnesota, there are more than

350 retail and wholesale florist establishments doing an annual business of $25,000,000. Additional statistics can be quoted to describe the importance of ornamental horticulture businesses to the economies of other midwestern states. The approximate value of nursery products sold annually in the north central states is more than $43,000,000, and the approximate value of cut flowers, potted plants, florist greens, and bedding plant grown in the north central states is more than $96,000,000.

The number of dealers licensed to retail nursery stock in Illinois has increased 25 percent during the past five years, and the number of nurseries licensed to grow and wholesale nursery plants in Illinois has increased 31.7 percent during the past five years.1/

In one state, it was determined that 22 percent of the total number of off-farm agricultural employees were employed in the field or ornamental horticulture.2/

1/ Dillon, Roy D. Comparison of Certain Abilities Needed by Workers in Licensed Nurseries and Licensed Ornamental Horticulture Businesses, Thesis, Ed.D., 1965, Library, University of Illinois, Urbana, Illinois.

2/ Judge, Homer V. Employment Opportunities and Needed Competencies in Off-Farm Agricultural Occupations in Massachusetts, Research Report, 1965, Department of Education, Boston, Massachusetts.

CHAPTER II

PROCEDURES

Outline of Activities Completed

The activities that were carried out during the conduct of this project were as follows:

1. Training activities
   - a. Selection of teachers
   - b. Development of the institute program
   - c. Conduct of the institute program
2. Service activities
   - a. Preparation of teachers' source units
   - b. Preparation of laboratory exercises
   - c. Preparation of other teaching aids
3. Evaluation activities
   - a. Evaluation of institute program
   - b. Evaluation of curriculum materials
   - c. Survey of 1965-66 and 1966-67 programs conducted in schools where institute participants were employed and survey of 1967-68 plans
   - d. Staff visitations to schools
   - e. Follow up, evaluation meeting for institute participants

Training Activities

A summer institute for 30 vocational teachers was held on the University of Illinois campus from June 21 to July 15, 1966. Teachers who attended the institute were from Illinois, Indiana, Kansas, Kentucky, Michigan, and Missouri.

Selection of teachers. The summer institute was publicized by means of an institute brochure sent to teacher educators and supervisors of agricultural education in 13 midwestern states. These teacher educators and supervisors were asked to nominate experienced teachers from their states who might benefit from and make use of the institute program. Both the letter and the brochure sent to state staff members have been included in Appendix A.

One hundred sixty-one teachers who had been nominated by state supervisors of agricultural education or teacher educators in agricultural education were invited to apply for admission to the institute by completing an application form (see Appendix A). Each teacher who had been nominated was also sent an institute brochure.

Thirty teachers and eight alternates were chosen from a group of 75 teachers who applied for the institute. The selection process was conducted by an institute advisory committee consisting of two staff members from the Division of Agricultural Education, two staff members from the Department of Horticulture, two staff members from Vocational Agriculture Service, University of Illinois, and two state supervisors from the Agriculture Occupations Division of the Illinois Office of Public Instruction. The information supplied by teachers on their application forms plus information collected from personal telephone calls to certain high school administrators and state leaders in agricultural education was used by the committee to select prospective participants for the institute. Two of the 30 teachers were employed at junior colleges, and the others were employed in high schools or area secondary schools. The major criteria used in the selection process were the ability of the teacher to make use of the institute program in developing a program of vocational ornamental horticulture and the opportunity of the teacher to develop or improve an instructional program in his local school district.

Appropriate letters were sent to all teachers chosen by the advisory committee as well as to those who were not invited to participate in the institute (see Appendix A). Prior to the start of the summer session four alternates were substituted for teachers who decided they could not attend the institute.

Development of the institute program. Teachers who attended the summer institute at the University of Illinois were enrolled in two four-weeks courses. Horticulture 200C, Special Problems in Ornamental Horticulture, was scheduled from 8:00-11:00 a.m., five days per week and included the following areas of instruction:

1. Plant propagation
2. Greenhouse management
3. Nursery management
4. Turf management
5. Arboriculture
6. Ornamental gardening and landscaping

Each area was taught by a specialist from the Division of Floriculture and Ornamental Horticulture who used field and laboratory exercises as well as lecture-discussion procedures in his instructional program. One of the highlights of Horticulture 200C was a two-day field trip to the Chicago area to observe operations at nurseries, greenhouses, a garden center, a turf farm and research station, and an orchid production center. The institute participants were accompanied on this field trip by Professor John B. Gartner, Chairman of the Division of Floriculture and Ornamental Horticulture, who planned and conducted the tour.

A second course entitled Votec Education 459, Workshop in Curriculum Development, was scheduled from 1:00 to 3:00 p.m., five days a week and included the following areas of instruction:

1. Developing instructional programs in ornamental horticulture
2. Developing course outlines
3. Developing teaching outlines and laboratory exercises
4. Conducting ornamental horticulture programs in area schools
5. Selecting teaching aids and references
6. Planning and supervising experience programs
7. Evaluation and committee reports

Votec Education 459 was taught by the project director with assistance from Mr. Ernest Stedge, teacher of ornamental horticulture, West Nyack, New York. Mr. Stedge served as a consultant in Votec Education 459 during the second week of instruction.

The primary purpose of Votec Education 459 was to develop teaching units which were related to the content taught in Horticulture 200C. The period of time from 3:30-5:00 p.m. each day was earmarked as time for committee work and individual projects. The project director was available for conferences and consultation during this period.

Teachers received three semester hours of undergraduate credit for Horticulture 200C and ½ unit of graduate credit for Votec Education 459.

Conduct of the institute program. Of the 30 teachers who attended the institute, nine were from states other than Illinois and 21 were from Illinois. Invitations to attend the institute were extended to a teacher from Minnesota and a teacher from Iowa but these teachers were unable to participate. The 30 teachers who completed the institute program and the schools where they were employed are as follows:

Donald Barrett, Harvard High School, Harvard, Illinois
James Becker, Amboy High School, Amboy, Illinois
Lewis Brown, Poplar Bluff High School, Poplar Bluff, Missouri
Robert Brown, De Kalb High School, De Kalb, Illinois
W. C. Brokaw, Geneseo High School, Geneseo, Illinois
Joe Chumbler, Heath High School, West Paducah, Kentucky
William Cinnamon, Brimfield High School, Brimfield, Illinois
Glenn Curl, Rochelle High School, Rochelle, Illinois
Joseph Dallon, Woodrow Wilson Junior College, Chicago, Illinois
Robert Dorch, Lincoln High School, Lincoln, Illinois
Patrick Dougherty, Grand Blanc High School, Grand Blanc, Michigan
Alice Dries, Danville Junior College, Danville, Illinois
William Eagleton, Alton High School, Alton, Illinois
Walter Ellison, Virgie High School, Virgie, Kentucky
Dean Finch, Forreston High School, Forreston, Illinois
Clarence Fluegel, Oswego High School, Oswego, Illinois

Justin Graves, Bloomington High School, Bloomington, Illinois
Irving Huggins, Ho-No-Ne-Gah High School, Rockton, Illinois
Donald Mayer, St. Clair High School, St. Clair, Michigan
Royal McCormick, Rock Falls High School, Rock Falls, Illinois
Robert Mills, Manteno High School, Manteno, Illinois
Rolla Mitchelle, Villa Grove High School, Villa Grove, Illinois
Edwin Sauer, Fisher High School, Fisher, Illinois
Arthur Schick, Sterling High School, Sterling, Illinois
Dale Smith, Erie High School, Erie, Illinois
Albert Tieken, Dixon High School, Dixon, Illinois
Michael Yocam, Paola High School, Paola, Kansas

Each teacher was paid a $300 stipend and travel expenses for one round trip from his home to the University of Illinois. Service fees, laboratory fees, and tuition were paid or waived for all participants. The teachers agreed to attend the institute program and to try out and evaluate certain curriculum materials which the research staff planned to develop. Also, the institute participants agreed to furnish research data as requested by the project director during the 1966-67 school year. The teachers were encouraged but not required to live together in a university dormitory reserved for institute participants.

During the institute period teachers were involved in a number of field trips and special activities which were carried out as a part of Horticulture 200C and Votec Education 459. One of these activities was a two-day field trip to northern Illinois to visit ornamental horticulture businesses. The group traveled by charter bus and visited the following horticultural operations:

1. Bork Nursery, Onarga, Illinois
2. Warren's Turf Nursery, Palos Park, Illinois
3. Hausermann's Orchids, Inc., Elmhurst, Illinois
4. Amley's Flowerland and Garden Center, Chicago, Illinois
5. Charles Fiore Nurseries, Prairie View, Illinois
6. George Weiland Greenhouses, Prairie View, Illinois
7. D. Hill Nursery, Dundee, Illinois

The field trip was arranged by Professor John B. Gartner who selected the businesses to be visited and served as tour guide.

Other special activities which teachers participated in as a part of the institute program were a field trip to Danville Junior College to observe a vocational ornamental horticulture program at the post-secondary level and discussion sessions with Mr. Ernest Stedge, Head of Ornamental Horticulture, Rockland County Center of Technology and Education, West Nyack, New York.

In Votec Education 459, committees were formed to represent the major area of content. The areas for which committees were formed were arboriculture, nursery management, greenhouse management, turf management, plant propagation, landscaping, and flowers and ornamental plants. Each committee member was required to prepare a teacher's source unit following an outline developed by the class. The 30 source units were later revised by the research staff, duplicated and sent to all institute participants for field testing and evaluation.

A collection of reference books, manuals, and other teaching aids was made available to teachers for study and review. The class members ordered and paid for personal copies of The Ball Red Book and free copies of florist supply and plant catalogues were handed out. Several handouts were distributed to class members by resource persons and materials from various states were exchanged by teachers in the class.

During the summer institute members of the research staff collected descriptive data on each of the school programs represented by the institute participants. The research staff also used the institute participants as a sounding board to find out what kinds of curriculum materials would be most useful in their schools.

Service Activities

The major types of service activities performed by the project staff were the preparation and revision of source units, preparation of laboratory exercises, and preparation of other teaching aids. Services were also performed by project staff members during visits to schools where teachers were employed but the primary purposes of these visits were to evaluate the curriculum materials developed by the research staff and to evaluate the effectiveness of the summer institute.

Preparation of teachers' source units. As described earlier in this chapter each teacher was charged with the responsibility of developing a source unit during the summer institute. The titles of the 30 source units prepared by teachers were as follows:

Plant Propagation

Selecting growing mediums
Studying plant growth and development (plant processes)
Propagating plants asexually
Propagating plants sexually
Selecting and using plant growth substances

Flowers and Floral Arrangements

Storing and caring for cut flowers
Arranging bouquets and floral pieces
Judging flowers

Greenhouse Management

Soil sterilization
Transplanting seedlings and cuttings
Controlling light, temperature and humidity in greenhouse or climatarium
Special structure for greenhouse management
Propagating greenhouse plants
Forcing lilies for Easter

Turf Management

Establishing a lawn by seeding
Sodding lawns
Maintaining the established lawn
Renovating lawns

Arboriculture

Identification of trees and shrubs
Selecting trees and shrubs
Cultivating and mulching trees and shrubs
Fertilizing trees and shrubs

Nursery Management

Planting, transplanting, pruning and training nursery crops
Nursery container production
Maintaining soils in the nursery
Establishing and preparaing the nursery site

Landscaping

Developing landscape designs
Landscape planning and drawing
Constructing terraces, ponds and pools
Landscape maintenance

The outline which teachers were asked to follow in preparaing their source units was as follows:

1. Name of problem area or unit
2. Grade level to be taught
3. Teaching objectives
4. Estimated number of class periods required
5. Content outline
6. Suggested ways of starting problem area
7. Suggested list of questions to be answered
8. Suggested list of laboratory exercises
9. Suggested student references (indicated pages to be studied)
10. Suggested teaching aids, equipment, and materials
11. Suggested special activities including field trips, class projects, experience program activities, and school service projects.

At the close of the summer session each source unit was edited by the research staff, mimeographed, and distributed to the 30 institute participants and 24 additional teachers who agreed to help field test the units. The selection of the group of 24 teachers and the process used in evaluating the source units has been described more fully in the evaluation section of this report.

During the spring semester of 1966-67, the research staff began to revise the source units incorporating suggestions and amendments received from teachers in the field. A decision was made to consolidate the 30 source units into seven source units and to rewrite certain sections completely. The final revision of the source units was completed during the summer of 1967, and appears in this report as Appendix B.

Preparation of laboratory exercises. The preparation of laboratory exercises for student use was begun during the summer of 1966 and continued throughout the 1966-67 academic year. By the first week of September 1966, each institute participant and each of the 24 teachers in a volunteer group had received copies of the following exercises:

1. Effect of lack of minerals on plant growth
2. Effect of seed germination in different media
3. Effect of presoaking on seed germination
4. Germinating seeds
5. Transplanting seedlings to pots
6. Effects of different media on rooting
7. Effects of different media and rooting compounds on rooting
8. Formation of roots by air-layering
9. Softwood cuttings
10. Simple layering
11. Effects of different watering intervals on plants growing in different media
12. Rate of transpiration
13. Overgrowth induced by the application of chemicals
14. Rooting of kalanchoe piannata (bryophyllum)
15. Effects of light on photosynthesis
16. Effect of a deficiency and additional carbon dioxide on plant growth
17. Effect of filtered light on photosynthesis
18. Effect of different light colors on phototropism
19. Effect of oxygen deficiency and excess oxygen on seed germination
20. Effects of pinching on plants that exhibit and do not exhibit apical dominance
21. Effect of p^H levels on plant growth
22. Effect of light and darkness on plants
23. Effects of growth regulators on plants

Between October 1, 1966 and March 1, 1967, the research staff prepared and distributed to teachers who were cooperating in the field testing program the following student laboratory exercises:

1. Planting a balled and burlapped tree
2. Bud and cleft grafting
3. Balling and burlapping young trees
4. Bracing trees and limbs
5. Pruning shrubs
6. Pruning hedges

7. Pruning mature trees
8. Fertilizing large trees
9. Establishing a new lawn with plugs
10. Making signs and markers for ornamental horticulture
11. Making moss sticks for climbing vines
12. Preparing a terranium showcase for small plants
13. Mixing potting soils
14. Making a corsage
15. Espaliering
16. Constructing a flat
17. Constructing a growing bench
18. Constructing a hotbed
19. Constructing a plant grower
20. Building a portable lath screen
21. Building a climatarium
22. Sharpening a garden hoe
23. Identifying garden tools
24. Plant grow and study mobile
25. Developing a landscape plan
26. Effect of oversterilization of soil on plant growth
27. Turf species and variety plots
28. Turf management demonstration plot

The first series of laboratory exercises was prepared by the research staff with the helpful suggestions of one or two teachers who were attending the institute at the time. All of the laboratory exercises were sent to the 54 teachers who had agreed to field test and evaluate the curriculum materials. Using the feedback received from teachers all of the laboratory exercises were revised and one was eliminated entirely. The 50 revised exercises are included in this report as Appendix C.

Preparation of other teaching aids. In addition to the source units and laboratory exercises, an experience program planning guide and record book was developed and a newsletter prepared. Both of these aids were sent to the 30 institute participants. Six teachers volunteered to have their students use the experience program planning guide and record book for one semester and to evaluate it. This guide and record book was developed to serve students enrolled in ornamental horticulture courses who are involved in placement-employment programs or are conducting improvement projects in home and grounds beautification. A copy of the book has been included in this report as Appendix D.

One of the purposes of this project was to help teachers with teaching procedures and to disseminate successful practices used in the schools were ornamental horticulture was being taught. The research staff visited schools where teachers were trying out new ideas and observed classes in ornamental horticulture. In order to disseminate to all of the institute participants those ideas gained from school visits, the research staff prepared and distributed a newsletter. A copy of the newsletter has been included in this report as Appendix E.

Evaluation Activities

Evaluation was conducted on three separate programs. First, the institute program conducted at the University of Illinois was evaluated. Second, the curriculum materials developed by the research staff and field tested by teachers in their schools were evaluated. And third, data on the instructional programs offered in the 30 schools where institute participants were employed were collected and summarized. The results of these evaluations are outlined in detail in another chapter of this report.

Evaluation of the institute program. Data regarding the summer institute program were collected from teachers by means of a questionnaire administered on the last day of the institute and by solicitation of opinions of institute participants regarding the value of the institute program in helping them improve their instructional programs. The latter type of data was collected from teachers at the close of the 1966-67 school year. The questionnaires and survey forms used to secure evaluative data are included in Appendix F.

Evaluation of curriculum materials. Feedback from teachers regarding the practicality and value of source units and laboratory exercises was obtained from teachers by means of two evaluation forms (see Appendix F). Each teacher was sent a supply of these forms and asked to complete one form for each source unit or laboratory exercise used in his teaching program. Additional comments regarding curriculum materials were obtained from teachers during school visits and during the follow-up conference for institute participants held June 9-10, 1967, at the University of Illinois.

Survey of programs conducted in schools during the 1965-66 and 1966-67 school years. During the summer institute, teachers were asked to complete two survey forms which were designed to collect information regarding ornamental horticulture programs conducted in schools in 1965-66 and programs planned for the 1966-67 school year. At the close of the 1966-67 school year teachers were asked to complete a final report on what had been taught during the year and on plans for the 1967-68 school year. The results of these surveys are presented in another section of this report. The forms used to collect the data are included in Appendix F.

Staff visitations to schools. All but one of the teachers who attended the summer institute were visited at their schools during the 1966-67 school year or the summer of 1967 by a member of the research staff. The major purposes of these visits were as follows:

1. To observe classes in ornamental horticulture and to learn about the instructional program
2. To offer assistance to the teacher and the school administrator in the development of an ornamental horticulture program
3. To collect data needed to evaluate curriculum materials and the institute program

The staff member who made a school visit was required to write a report of his visit and to circulate it among the other members of the research project staff.

Follow-up evaluating meeting. A two-day follow-up meeting for all institute participants was held at the University of Illinois on June 9 and 10, 1967. The purposes of the meeting were to give teachers the opportunity to report on progress made in developing instructional programs, to evaluate curriculum materials in a "group" setting, and to provide institute participants with an up-to-date report of the research project. Nineteen of the 30 teachers attended this conference.

CHAPTER III

EVALUATION

The evaluation program carried out as a part of this project included the following types of evaluation:

1. Evaluation of the summer institute
2. Description of programs in schools
3. Evaluation of source units
4. Evaluation of laboratory exercises
5. Evaluation of the record book
6. Publicity and recognition

The summer institute was evaluated by administering a questionnaire to participants on the last day of the institute.

The programs of ornamental horticulture instruction offered in the 30 schools where institute participants taught were surveyed at three different times. Programs offered in the 30 schools in 1965-66 were surveyed at the beginning of the summer institute. The program plans which teachers had for the 1966-67 school year were surveyed at the close of the summer institute. Actual accomplishments in ornamental horticulture instruction during the 1966-67 school year were surveyed in May and June, 1967. Supplementary information regarding accomplishments for each school was collected during school visits and at the follow-up evaluation conference held at the University of Illinois, June 9-10, 1967. Curriculum materials including source units and laboratory exercises were evaluated with appropriate evaluation forms completed by teachers after they had used a particular unit or exercise. Also, additional evaluations of curriculum materials were secured during school visits, at the evaluation conference, and through correspondence with teachers.

A group consisting of 24 teachers who had applied for admission to the institute, but were not accepted, was established as a control group. These teachers were sent all of the curriculum materials which the 30 institute participants received. They were asked to teach as many of the units as possible and to evaluate the content of both the source units and the laboratory exercises. As the school year progressed, it became evident that the teachers in the control group were using only a limited amount of the curriculum materials sent them and they were teaching few units in their entirety. The project director decided that any attempt to measure student learning in the cooperating schools or to compare one or more schools with other schools would result in meaningless data. Therefore, only the teachers' opinions regarding curriculum materials used were counted as a part of the final evaluation.

Evaluation of the record book and publicity programs were carried out on an informal basis and in a limited manner. Actually, these two areas of activity were not included in the purposes of the project plan but were added later as appropriate supplementary activities.

Evaluation of Summer Institute

On the last day of the summer institute, teachers were asked to respond to items on Form 3, Evaluation of Ornamental Horticulture Institute. A summary of the opinions of the 30 teachers who attended the institute are summarized in this section.

Horticulture 200C. The institute participants were asked to rate each of the six content areas of Horticulture 200C according to its value to them in starting a new ornamental horticulture program or improving their present program. In general, institute participants gave a high rating to the areas covered in Horticulture 200C. The participants did comment that more time should have been spent in laboratory and field work in plant propagation, greenhouse management, nursery management, and arboriculture.

All but four of the institute participants rated the two-day field trip to horticultural businesses in the Chicago area as "highly valuable." The other four participants rated the trip as "moderately valuable."

Other phases of the Horticulture 200C course which were considered valuable by the institute participants were class demonstrations and turf tours. Suggestions for improving Horticulture 200C included the granting of graduate credit, increasing the time spent on plant identification, and gearing the instruction more closely to what should be taught in a vocational course at the high school level.

Votec Education 459. Institute participants were asked to rate the various components of Votec Education 459, Workshop in Curriculum Development. Areas of work which received the highest ratings were term projects (development of source units), class demonstrations, course of study planning, and committee work. Activities which received low value ratings were presentation of source unit material by class members and reading assignments. Suggestions made by institute participants for improving Votec Education 459 were as follows:

1. Correlate Votec Education 459 and Horticulture 200C to a greater degree.
2. Use resource person from the Midwest.
3. Spend more time on committee work to develop source units.
4. Publicize the fact that teachers were participating in the institute in the teachers' home town newspapers.

Description of Programs in Schools

The institute participants were asked to furnish information about programs of ornamental horticulture offered in their schools during the 1965-66 school year and the 1966-67 school year. Copies of Form 1, Form 2, and the Final Report form are included in Appendix F. Forms 1 and 2 were administered to teachers during the summer institute and the Final Report form was completed by teachers at the close of the 1966-67 school year. All of the teachers who attended the institute completed Forms 1 and 2, and all but one teacher completed the Final Report form.

Form 1 was used to survey the nature and extent of ornamental horticulture offerings in the schools where institute participants were employed. Form 2 was used to determine what teachers planned to offer in ornamental horticulture during the 1966-67 school year, and the Final Report form was used to determine what actually had been offered in 1966-67. The data collected with the Final Report form provide a more accurate picture of what was accomplished in the pilot schools during the 1966-67, than do the data collected with Form 2. In this report, the findings from Form 1 and the Final Report form will be presented and the findings of Form 2 (what teachers planned to do) will be omitted.

Programs offered in cooperating schools in 1965-66. Programs of ornamental horticulture offered in the 30 cooperating schools during the 1965-66 school year varied greatly in terms of numbers of students reached and periods of instruction provided. Twenty-one separate courses were offered in nine of the 30 cooperating schools. Eleven of these courses were offered in two junior colleges and ten separate courses were offered in eight secondary schools. The titles of courses in the cooperating schools and the number of schools offering each course are as follows:

Titles of separate courses	Number of schools
Ornamental Horticulture	6
Landscaping	3
Turf Management	3
Arboriculture	1
Horticulture Mechanics	1
*Greenhouse Management	1
*Commercial Floriculture Crops	1
*Floral Design and Shop Management	1
*Floriculture	1
*Orientation	1
*Identification and Use of Plants	1
*Insect and Disease Control	1
*Plant Propagation and Breeding	1

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*The course titles marked with an asterisk were taught at the post-secondary level only.

Twenty-one of the 30 teachers who participated in the institute program taught some ornamental horticulture units as a part of their regular vocational agriculture program during the 1965-66 school year. The areas most frequently taught to vocational agriculture students were plant propagation, turf management, ornamental gardening and landscaping, arboriculture, and nursery management. Greenhouse management units were taught to regular vocational agriculture students in only seven of the 30 schools included in this study.

In 1965-66, ten of the 30 cooperating schools had students involved in placement-employment programs at ornamental horticulture training stations. Two of these ten schools were post-secondary institutions. The types of training stations used by schools and the number of each type used in 1965-66 are listed below:

Types of training stations	Number of training stations
Nursery	13
Home Improvement	11
Floral Shop	6
Greenhouse	6
Golf Course	6
Research Farm	4
Garden Center	4
Landscaping Service	2
Turf Farm	1
Cemetery	1
Building and Trade House	1

Programs offered in cooperating schools in 1966-67. The year 1966-67 was the school year which followed the summer institute program. Two sets of forms were used by the project director to collect data regarding programs planned and carried out during the 1966-67 school year. Form 2, administered during the last week of the institute, was used primarily to secure a mental commitment from institute participants as to what they planned to do in their schools during the coming year. The Final Report form, administered at the close of the 1966-67 school year, was designed to identify actual accomplishments in the schools. Since accomplishments rather than plans are most important in the evaluative process, only the data collected at the close of the school year are presented in this report.

Thirteen of the 30 cooperating schools offered separate ornamental horticulture courses during the 1966-67 school year. Twenty-six of the 30 cooperating schools taught ornamental horticulture units to their regular vocational agriculture students. In order to secure a more accurate picture of the total instructional effort put forth in 1966-67 in the schools where institute participants were employed, the research staff calculated the number of "student periods" devoted to ornamental horticulture in each school. A student period was defined as one student engaged in ornamental horticulture classwork for one period (one hour) of time. In Table 1, the total number of student periods and the mean student periods taught at each of four grade levels are presented.

Table 1.--Student Periods* of Instruction Devoted to Ornamental Horticulture at Each of Four Grade Levels, 1966-67 (N=27)

Grade level	Schools involved	Total student periods taught	Mean student periods
Ninth	13	3,101	238.5
[illegible]h	18	8,072	448.4
Eleventh	20	22,801	1,190.0
Twelfth	17	26,306	1,547.0

* A student period is defined as teaching one student for one class period of 60 minutes.

As shown in Table 1, most of the instructional time for ornamental horticulture is concentrated in the eleventh- and twelfth-grade levels. The instruction provided in the ninth- and tenth-grade levels was, for the most part, integrated with the traditional vocational agricultural courses.

Two of the institute participants were teachers of vocational ornamental horticulture at junior colleges. One of these teachers reported that 6,696 student periods were taught at the thirteenth-grade level, and the other junior college teacher reported that 4,104 student periods of ornamental horticulture were offered at the fourteenth-grade level.

One way to evaluate the effectiveness of the summer institute and the related activites in curriculum development is to compare what took place in the 30 cooperating schools the year before and the year after the institute. In Table 2, data are presented which show a definite growth in all aspects of the program. For this particular table, data from the two junior colleges were omitted because most of the criteria do not fit these institutions.

Table 2.--Comparison of Ornamental Horticulture Programs Conducted in 28 Cooperating High Schools, 1965-66 and 1966-67 (N=28)

Categories	1965-66	1966-67
Number of students taught in separate ornamental horticulture classes	139	235
Number of schools teaching separate ornamental horticulture courses	7	11
Number of separate ornamental horticulture courses taught	11	14
Number of students who received instruction in ornamental horticulture as a part of a regular vocational agriculture course	600	772
Number of students involved in placement-employment in ornamental horticulture	95 (8 schools)	99 (13 schools)
Number of schools teaching ornamental horticulture as a part of the regular vocational agriculture program	21	26

Changes made in facilities and equipment. Another measure of progress in program development--in addition to the number of students, classes, and student periods of instruction--is the addition of new facilities and equipment. For some schools this "tooling up" for the future was the major accomplishment of the year.

Twenty-two teachers reported that they had purchased new reference materials on ornamental horticulture during the year. Three greenhouses were constructed and many items of equipment including fans, foggers, tree planters, hand tools, Growlux lamps, climatariums, cold frames, misting equipment, automatic timers, fertilizer injectors, flats, cooler for cut flowers, and other equipment for laboratory work were purchased.

All of the institute participants purchased some books and other reference materials for the library, and several teachers subscribed to new magazines, purchased slides and filmstrips, and ordered wall charts.

Laboratory equipment and supplies purchased by teachers during the 1966-67 school year included the following:

- Fertilizer and media
- Pots
- Bulbs, seeds, and cuttings
- Trees and shrubs
- Hormones and chemicals
- Electric cables
- Slides
- Plant food demonstration kits
- Hydroponic growth kits
- Grafting equipment

Several changes and improvements in facilities were made in schools where the institute participants taught. Some of the improvements made in facilities and the number of teachers reporting each improvement are as follows:

Improvement	Number of teachers reporting
Added a plant grower	5
Remodeled classroom or shop	5
Built a greenhouse	3
Made use of science greenhouse	3
Improved school grounds	3
Established a demonstration plot	2
Built hotbeds or pithouses	2
Acquired climatarium	3

Several teachers developed plant growing areas in the shop and enclosed them with plastic to control the humidity and temperature. One teacher and his students planted 3,000 ornamental trees in cans. Another group planned landscape programs for 15 homes and planted trees and shrubs. One teacher reported that his class performed corrective surgery on 25 fruit and shade trees. Another class group set out 2,000 Christmas tree seedlings and 250 five-year seedling pine and wildlife-cover plants on ten farms in the community. In a few schools, the growing and distribution of vegetable plants is an important activity. One teacher reported that his class grew and distributed 3,500 tomato plants and 200 cabbage plants.

Twenty-six of the 30 teachers reported that their students had been involved in community or school service projects related to ornamental horticulture during the 1966-67 school year. Types of projects accomplished and the number of schools involved in each project are as follows:

Project	Number of schools involved
Maintain school grounds	19
Plant shrubs for local homeowners	8

Project	Number of schools involved
Grow and distribute plants	7
Distribute plants to local groups	5
Care for football field	5
Furnish plants for school offices and libraries	4
Develop school flower beds	3
Construct booths and displays	2
Help control insects in the community	1
Conduct a program for the Garden Club	1

Another phase of the ornamental horticulture program which teachers participated in during the 1966-67 school year was the adult education phase. Seven of the 30 institute participants taught ten courses to adults. Some of the topics discussed at these adult meetings were lawn care, landscaping, maintaining trees and shrubs, and buying plants.

The range of attendance at the adult classes reported in the study was 16-200, and the mean attendance at adult meetings was 64. One institute participant was asked to conduct a workshop on how to teach ornamental horticulture in the public schools to fellow teachers in his state.

Other program changes which teachers made in 1966-67 included adding new units of instruction, changing the titles of courses, establishing new courses, starting experience programs, and changing teaching procedures. One teacher developed a flannelboard to use in the teaching of landscaping and a plant identification card to use in tree and shrub identification work.

Plans for the future. Several teachers who attended the summer institute were unable to make any major changes in their class schedules for the 1966-67 school year. By the time the teachers returned to their schools, it was too late for some of them to organize and start new courses. For some teachers, 1966-67 was a planning year and 1967-68 was designated as the year to start new courses. Twenty-six of the 30 institute participants reported that they planned to make major changes in their instructional programs in 1967-68. Six teachers planned to start separate courses in ornamental horticulture and ten teachers planned to change the structure of their vocational agriculture program. Nine teachers planned to change facilities in 1967-68 so as to facilitate the teaching of ornamental horticulture.

Factors which influenced teachers to change their programs. Teachers who attended the institute were asked to rank ten factors according to the influence these factors had on bringing about changes in the program. The factors ranked by the teachers and the mean ranking given each factor were as follows:

Factor	Mean rank
My personal interest in horticulture	2.23
Instruction received in Horticulture 200C	2.36
Instruction received in Votec Education 459	2.52
Instruction received in extramural horticulture courses	2.6
Curriculum materials received from project	3.15
Other factors	3.3
Community need	3.55
Contacts with other teachers at the institute	3.65
Assistance from local industry	4.38
Pressure from board of education or school administration	5.00

The reader should realize that not all of the teachers had opportunities to be influenced by certain factors. For example, not all of the teachers were enrolled in extramural horticulture courses.

Factors which inhibited program development. The teachers who attended the summer institute were asked to identify the factors which prevented them from accomplishing more towards ornamental horticulture program development than they did accomplish during the past year. The factors which teachers listed and the number of teachers who listed each factor were as follows:

Factor	Frequency
Lack of facilities	11
Lack of teacher time	7
Lack of support from school administration	5
Lack of motivation on the part of the students	5
Lack of local need	3
Insufficient students to warrant a separate class	3
Limited ability of the teacher	2
Do not wish to cut back production agriculture program in favor of ornamental agriculture	2
Lack of high school level reference material	2
Lack of text material in nursery management	1
Lack of support from board of education	1
Lack of class time	1
Teacher resists change	1
Lack of money to buy equipment	1
Students had to be bussed from one school to another	1
Difficult to schedule students	1
Started to think about it too late in the year	1
Insufficient training stations	1
Lack of parental support	1

What teachers want from state staffs in agricultural education. Teachers were asked to respond to an open-ended item asking what state staff persons could do to get more ornamental horticulture programs started. Their suggestions have been summarized in the following list:

1. Conduct college credit workshops and special courses in ornamental horticulture for in-service training of teachers
2. Provide more subject-matter units and teaching aids
3. Facilitate the exchange of ideas between teachers who have taught ornamental horticulture and those who have not
4. Develop demonstrations and laboratory exercises for class use
5. Conduct sessions devoted to ornamental horticulture at the state teachers' conference and FFA convention
6. Place student teachers in cooperating schools where ornamental horticulture is taught
7. Help inform school administrators, local directors of vocational education, and counselors of the functions of ornamental horticulture programs in the schools
8. Become cognizant of the place of girls in an ornamental horticulture program
9. Encourage colleges of agriculture to count horticulture as a science credit
10. Require prospective teachers to take more courses in horticulture
11. Develop teacher education programs for undergraduates who wish to major in ornamental horticulture
12. Promote more off-campus and summer courses in ornamental horticulture
13. Conduct one-day tours for teachers to visit schools where ornamental horticulture is taught

Reports of school visits. Twenty-nine of the 30 teachers who attended the summer institute were visited by a research staff member during the 1966-67 school year or the summer of 1967. The purposes of these visits were to collect data regarding program development, to assist teachers in the implementation of what they learned at the summer institute, and to provide consultative services to the schools. Both personal contacts and mail contacts were used to promote the development of ornamental horticulture instruction. In several of the schools no separate courses in ornamental horticulture were started in 1966-67 but units of instruction were integrated into the regular vocational agriculture program. Some of the teachers decided that they did not have enough students to justify a separate course in ornamental horticulture. In some schools students interested in preparing for ornamental horticulture occupations were enrolled in an agricultural occupations course which served students interested in a wide array of agricultural jobs.

The follow-up visits to schools were an important part of this research and development program. These visits enhanced the development of instructional programs and provided the research staff with valuable ideas regarding the development of appropriate curriculum materials. The evaluation data collected during school visits were combined with the data obtained from the final reports and were reported earlier in this chapter.

Evaluation of Source Units

During the summer institute each teacher was asked to prepare a teacher's source unit for a problem are related to plant propagation, greenhouse management, nursery management, turf management, arboriculture, landscaping, or flowers and floral arrangements. A common outline was used by teachers in the preparation of their units. The teachers had only two weeks to work on their units after the advance planning and preparations had been accomplished. At the close of the institute, a decision was made to make the 30 source units available to institute participants and a few other teachers for field testing and evaluation during the 1966-67 school year. The research staff spent about two months revising the units and making a limited number of improvements. Then, the 30 units were duplicated and sent to the 30 institute participants and 24 other teachers early in September 1967.

The control group of 24 teachers was selected by asking applicants who had not been selected for the summer institute to field test and evaluate the source units and laboratory exercises. In soliciting the cooperation of the control group the project director emphasized the fact that teachers would not be obligated to use all of the source units and laboratory exercises which they received but for each unit or exercise used, an evaluation form should be completed. The evaluation form which was used by teachers to evaluate the source units has been included in Appendix F.

Changes suggested by teachers. No attempt was made to compare the evaluations made by institute participants with those made by teachers in the control group. The evaluations made by teachers in the control group were very limited and brief. Apparently, these 24 teachers who were not involved in the preparation of the source units did not use them extensively in their teaching. Also, a number of teachers in the control group reported that they had used parts of several source units but did not feel they could evaluate a unit fairly when it was not used in its entirety.

The institute participants used a greater number of source units in their teaching than did the control group; although no information regarding the exact number was collected. Since some teachers did not complete an evaluation form for each source unit used, additional information regarding the value of the source units was collected during school visits and during the follow-up conference held in Urbana on June 9 and 10, 1967. All of the suggestions obtained from teachers were combined in developing the following list of suggested improvements:

1. Teachers wanted answers to all study questions written out and included in the source units. In several of the original units the reader was referred to a page or pages in a given text for the answers to study questions.
2. Teachers felt the number of books and other study materials referred to in the source units should be reduced so that a school would not have to buy so many different books.
3. Several teachers suggested that the introductory sections on how to use the unit, objectives, and ways of starting the unit should be consolidated.
4. For some of the source units teachers suggested that changes be made in the amount and level of content included or in the kinds of teaching aids suggested.
5. Teachers from states other than Illinois indicated that they preferred to use free circulars from their own land-grant colleges rather than order those Illinois circulars listed in some of the source units.
6. Teachers suggested that a series of transparencies or slides be made available to assist them in teaching the landscaping unit.
7. Teachers in junior colleges indicated that the source units probably were most useful at the secondary level.

In addition to these general suggestions, teachers made many specific suggestions regarding the content included in the source units or the suggested procedures for teaching the units. In each instance, the research staff made a decision regarding the use of the suggestion in the final revision. The revised source units are included in Appendix B.

Evaluation of Laboratory Exercises

During the 1966-67 school year, 50 laboratory exercises were developed and sent to the teachers who attended the institute and to the teachers in the control group. The procedure used to field test and evaluate the source units was also used for the laboratory exercises. Feedback from teachers was obtained by using an evaluation form (see Appendix F), and by personal interviews during school visits and at the follow-up conference. Ideas regarding the type of exercises to be developed were obtained from teachers and from suggestions included in the source units. Most of the teachers in the control group did not use the laboratory exercises developed by the research staff. Apparently, the instructional program in these 24 schools had not developed to the point where equipment was readily available or where the course of study called for student involvement in laboratory work. All of the institute participants used one or more laboratory exercises in their teaching programs. None of the teachers used all of the 50 exercises but several teachers used the exercises in the adult as well as the high school program.

Changes suggested by teachers. Many of the changes suggested by teachers were changes in wording or changes in laboratory techniques. As a result of the field testing process one of the original exercises was eliminated entirely and two others were combined into one exercise. Some of the general suggestions made by teachers for improving the laboratory exercises were as follows:

1. Develop more exercises which involve greenhouse or nursery skills instead of exercises of the "experimental" type commonly carried out in science courses.
2. Add drawings, diagrams, and illustrations whenever possible so that students can follow directions easier.
3. Provide questions at the end of each exercise for students to answer.
4. Develop a teaching order for the 50 exercises and publish the exercises in the form of a student laboratory manual.
5. Develop a teachers' key to go with the proposed manual.
6. For complicated exercises, suggest alternate procedures which call for fewer items of equipment or a lower level of student competency.
7. Define terms which may be new to students.

Most of the teachers agreed that the laboratory phase should be a dominant feature of any vocational program. Many of the skills and jobs which students must learn can be learned best on the job, but students who are not ready for placement or cannot secure job experience should be provided with laboratory experiences at school.

Evaluation of the Record Book

A record book entitled Ornamental Horticulture Experience Program Planning Guide and Record Book was developed by the research staff during the 1966-67 school year (see Appendix D). Since the book was not completed until February 1967, very little time was left for field testing during the 1966-67 school year. Each of the 30 institute participants was sent a copy of the record book and asked to order more copies if he felt his students could use the book during the second semester. Seven teachers requested 40 copies of the book for trial and evaluation. Feedback concerning the practicality of the record book for students involved in ornamental horticulture experience programs was secured during school visits and at the follow-up conference.

No changes were made in the record book as a result of the limited trial conducted during the spring semester. The teachers who used the book felt that it was very helpful. They offered no definite suggestions for changing the book but were very enthusiastic about its possible uses. Some of the teachers said they wanted to use it for a full year before making any suggestions for improving the book. Even though copies of the experimental edition of the record book were not distributed beyond the group of institute participants, other teachers have seen copies of the record book and have sent requests for copies. Within the period of one week the project director received requests for 95 copies of the record book.

Publicity and Recognition

No attempt has been made to publicize the results of this research project prior to the termination of the project except for an article published in the February 1967 issue of The Agricultural Education Magazine.[3] Many persons did become aware of the project during the time when teachers were being recruited for the summer institute and brochures describing the research project were being circulated. During the time the project was in progress the project director received several inquiries regarding the nature of the work being done and the possibility of receiving copies of the curriculum materials. Requests for curriculum materials came from persons in Indiana, Illinois, Kansas, Wisconsin, Minnesota, Ohio, North Carolina, Iowa, Kentucky, Michigan, and Missouri. At least two of the out-of-state teachers had the opportunity to report some of their institute experiences to state groups of vocational agriculture teachers. Several of the teachers who attended the summer institute corresponded during the 1966-67 school year and exchanged teaching aids and materials. Several Illinois teachers took additional course work in ornamental horticulture during the 1966-67 school year. Institute participants from Kentucky and Indiana attended state workshops or institutes at the University of Kentucky and Purdue University during the summer of 1967.

3/ Hemp, Paul E. "Coop Ornamental Horticulture Project," The Agricultural Education Magazine, Vol. 39, No. 8, February 1967, p. 175.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Restatement of the Purposes

This research and development project was designed to retrain teachers, to develop curriculum materials for vocational ornamental horticulture classes, and to stimulate the development of new programs of vocational ornamental horticulture in the Midwestern section of the United States.

Summary of Major Activities

The retraining phase of the project was carried out through a summer institute held at the University of Illinois in 1966. Thirty teachers from six states participated in the four-weeks institute and completed courses in ornamental horticulture and curriculum development. Twenty-eight participants were high school vocational agriculture teachers and two participants were vocational ornamental horticulture teachers at the junior college level.

The development of curriculum materials was started by the institute participants and completed by the research project staff at the University of Illinois. Seven source units to be used by teachers were prepared, field tested, and revised. Fifty laboratory exercises for students to perform at school or in the field were developed by the research staff, field tested by the institute participants, and rewritten by the research staff. A student record book was also developed and tested in a limited number of schools. The revised editions of the source units and laboratory exercises are available to teachers from The Interstate Printers and Publishers, Danville, Illinois.

New programs in vocational ornamental horticulture and improvements in existing programs were stimulated through follow-up visits made to schools, newsletter and other mailings, and a follow-up evaluation conference held at the University of Illinois in June 1967. The institute, the curriculum materials, and the status of programs in schools were evaluated through the use of evaluation forms, survey forms, and personal interviews.

Conclusions and Recommendations

A study of the data collected in this project suggests a number of conclusions and recommendations which are presented in this section of the report. The conclusions cannot be proved in the sense that a hypothesis tested in a controlled situation could be accepted or rejected, but they represent the best judgments of the research staff who planned the project, carried it out, and observed results in the field during an entire school year. In this report each conclusion or recommendation is discussed briefly and evidence which tends to support the conclusion or recommendation is presented.

1. The regional institute which brings teachers from several states together for study and professional interaction is an effective way of bringing about change in vocational programs. The federal grant used in this project made it possible for the University of Illinois to recruit teachers from six states to attend a summer institute. Part of the success of the institute was due to the ideas and experiences which teachers brought with them and shared with the group. Observations by staff members during school visits and comments from institute participants offer strong evidence that the diversity of experiences and opinions present in a group of teachers from several states serves as a catalyst to promote change.

2. In recruiting candidates for an ornamental horticulture institute, an effective procedure for sorting out teachers who have ample opportunities to develop new programs in their communities should be developed and used. If an educational agency wishes to work with those teachers who can and will do something about their programs at home, then every effort should be made to select teachers for the institute who are early adopters of approved educational practices. The employment opportunities for many kinds of ornamental horticulture workers are greatest in urban and suburban areas where affluent people live and where the population is growing. Before selecting teachers to participate in institutes where the development of new programs is important, the selection committee should contact school administrators to see if program changes are possible for the coming year.

3. Teachers of vocational agriculture who are attempting to retrain themselves in ornamental horticulture want and need sponsored job internship programs which would provide them with on-the-job experiences in greenhouses, nurseries, and landscaping businesses. Even though college courses include some practical experiences and field work, they do not take the place of first-hand experience in industry as a training device for vocational teachers. Teachers attending the institute rated a two-day field trip to businesses in the Chicago area as one of the most beneficial parts of the program.

4. University staff members who plan to offer teacher institutes which include horticulture subject matter and curriculum planning should plan the institute program so that a close correlation exists between the two components of instruction. In their evaluations of this institute teachers suggested that a closer correlation between Horticulture 200C and Votec Education 459 would have been desirable. One way to accomplish this correlation would be to offer two weeks of horticulture subject matter followed by a week of curriculum development. Teachers should not be asked to develop a teaching unit on a particular area until they have completed or nearly completed the horticulture subject matter which is to be covered in the unit.

5. There was a substantial increase in enrollment, course offerings, and program improvements when comparisons were made between the 1965-66 and the 1966-67 programs in the 28 high schools where institute participants taught. Many of the improvements teachers made in their programs were of a qualitative nature and could not be measured accurately but the staff members who visited the schools where institute participants taught were able to observe these changes firsthand. When teachers were asked to rate the factors which influenced them to change their programs they rated "Instruction Received in Horticulture 200C" and "Instruction Received in Votec Education 459" second and third, respectively, in a group of ten suggested factors.

6. The teachers who attended the summer institute believe state staff members in agricultural occupations should provide more in-service training for teachers, develop preservice training programs for prospective teachers of ornamental horticulture, prepare curriculum materials, and help sell programs to schools, school administrators, and teachers. Most teachers felt that some progress had been made in helping vocational agriculture teachers develop new programs but that more effort should be spent during the next few years.

7. In the schools where the institute participants taught, most of the instruction in ornamental horticulture was concentrated in the eleventh- and twelfth-grade levels. A survey of the programs offered at the cooperating schools in 1966-67 showed that more than 80 percent of the instructional time was used with students at the upper two grade levels. Many teachers felt that specialty programs such as ornamental horticulture should be offered only to junior and senior students who have completed basic agriculture, science, or biology.

8. Eleven of the 30 teachers rated "lack of facilities" as an inhibiting factor in program development in their schools. Most of the teachers who participated in the institute had to develop their own plant growing structures in the shop or classroom. None of the secondary schools which the research staff visited had provided the teacher of horticulture or agriculture with a "quality" greenhouse. Apparently, more needs to be done to help school administrators and others see the need for adequate greenhouse facilities.

9. There is a need for new curriculum materials especially written for secondary students. These materials should be written from the standpoint of what a prospective employee needs to know and needs to be able to do. Teachers cooperating in this project expressed a need for visuals on plant identification, transparencies explaining important landscaping principles, and text materials on nursery management.

10. Teaching outlines for adult education courses in the field of ornamental horticulture should be prepared as guides to show teachers, school administrators, and others what the possible content of such courses might be. The teachers who cooperated in this project and taught adult courses in ornamental horticulture reported that adults were eager to enroll in these courses and that representatives from industry were anxious to help in the teaching of adult courses.

11. Much needs to be done in the area of informing school administrators, counselors, and students about vocational ornamental horticulture programs and employment opportunities. Five of the 30 teachers who cooperated in this project reported that lack of support from the school administrator held them back in the development of a new program. Five teachers reported that students in their schools were not motivated to enroll in horticulture courses.

12. The titles of vocational ornamental horticulture courses should reflect the occupations for which these courses prepare persons. The most frequently used course title in the schools where institute participants taught was "Ornamental Horticulture." Other course titles used in these schools followed closely the titles of college courses. Part of the failure of teachers to communicate with counselors, students and parents may be traced back to the use of course titles which do not describe the occupational objectives of the vocational program.

13. The content of secondary courses in ornamental horticulture should reflect local needs as well as area and state manpower requirements. Courses of study offered in the 28 high schools where institute participants were employed varied a great deal. For example, in areas where home gardens are important, teachers included units on vegetable production. In other areas strong emphasis was placed on forestry including Christmas tree production. In areas where many new homes were being constructed, a strong emphasis was placed on landscaping and the planting of ornamental plants.

14. The opportunities for classes to conduct school and community service projects and for classes to engage in laboratory work on the school grounds are plentiful in most communities. In this project all of the cooperating teachers were able to involve their students in school and community projects which were closely related to the content of the courses being taught.

15. Vocational programs in some phase of ornamental horticulture should be developed in area schools or educational centers which serve several small school districts. In most midwestern states the typical small high school cannot justify a program in vocational ornamental horticulture; however, two or more students in the school are interested in preparing for employment in the ornamental horticulture industry. The need for a two-year program of vocational ornamental horticulture was probably not strong enough in at least six of the 30 schools cooperating in this study to justify the development of a new program. In such schools the student interested in horticulture can enroll in the vocational agriculture program to get the horticulture phase of each course or he can choose another field of study.

APPENDIX A

RECRUITMENT LETTER

NOMINATION FORM

APPLICATION FORM

INSTITUTE BROCHURE

LETTERS TO CNADIDATES

Division of Agricultural Education
University of Illinois
358 Education Building
March 10, 1966

TO: Teacher Educators and State Supervisors, Agricultural Education

SUBJECT: Nominations for University of Illinois Ornamental Horticulture Institute

The University of Illinois has recently negotiated a contract with the U. S. Office of Education to conduct a summer institute in ornamental horticulture for teachers of agriculture who wish to teach a course in vocational ornamental horticulture during the 1966-67 school year. The enclosed brochure describes the institute program and procedures to follow in applying for fellowships.

The training proposal provides financial remuneration for 30 teachers, 25 percent of whom must be recruited from Middlewestern states other than Illinois. Would you please use the enclosed form to nominate teachers from your state who should be sent the institute brochure and application form?

Sincerely yours,

l E Hemp

Paul E. Hemp, Director
Ornamental Horticulture Institute

PEH:tc
Enclosure: Brochure

University of Illinois
Ornamental Horticulture Institute
Nomination Form

Please send an application form and an Institute brochure to the following vocational teachers:

	Name	Address
1.	____________________	____________________
2.	____________________	____________________
3.	____________________	____________________
4.	____________________	____________________
5.	____________________	____________________
6.	____________________	____________________

Signed____________________

Return this form to:

Paul E. Hemp
Paul E. Hemp, Director
Ornamental Horticulture Institute
University of Illinois
358 Education Building
Urbana, Illinois 61820

APPLICATION FORM

University of Illinois Summer Institute For Ornamental Horticulture Teachers

1. Name____________________ 2. Address____________________

3. Name of school where presently employed____________________

4. Telephone____________________ 5. Age____________________

6. Highest degree held____________________

7. Grade point average: Undergraduate____________ Graduate____________

8. Years teaching experience____________________

9. Did you teach a course in ornamental horticulture during the 1965-66 school year?________

10. If answer to Item "9" is "Yes" identify major areas taught and number of students enrolled.____________________

____

____

11. Are you planning to teach an ornamental horticulture course at your school in 1966-67?________________. How many students will be enrolled?________.

12. Are you planning to teach ornamental horticulture units as a part of existing vocational courses?__________. List titles of units to be taught________

____

____

13. Work experience in ornamental horticulture. List jobs held and length of employment for each job.____________________

____

____

14. Educational background. List college courses or other courses taken in ornamental horticulture or closely allied areas.____________________

____

____

Return this form to: Paul Hemp, Director
University of Illinois
Ornamental Horticulture Institute
358 Education Building
Urbana, Illinois 61801

Mailing deadline - April 15, 1966

M/AE32sh
2/28/66

low-up and evaluative services to all teachers who participate in the Institute.

FINANCIAL ASSISTANCE

Each teacher who attends the Institute will receive a fellowship worth $300. In addition, each participant will be granted travel pay for one round trip to the University of Illinois and payments to cover the costs of tuition and laboratory fees.

SELECTION OF TEACHERS

No more than 30 teachers will be invited to participate in the Ornamental Horticulture Institute. The Institute Advisory Committee will make the selection of teachers who are to be offered fellowships. Enrollment will be limited to those persons receiving fellowships.

HOUSING

Living accommodations for single persons as well as married couples are available in University dormitories and private housing units. Food services are provided in most University owned dormitories. Rates for rooms in University dormitories range from $2.40 to $3.15 per day. Meal prices in University dormitories range from $3.12 to $3.43 per day.

CIVIL RIGHTS COMPLIANCE

In conducting this Institute, the University of Illinois will adhere to Sec. 601, Title VI of the Civil Rights Act which states that "No person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance."

ORNAMENTAL HORTICULTURE SUMMER INSTITUTE FOR VOCATIONAL TEACHERS IN THE MIDDLEWESTERN STATES

at the

University of Illinois
Urbana, Illinois

June 20 to July 15, 1966

Supported by the U. S. Office of Education under Section 4 (c) of the Vocational Education Act of 1963.

Division of Agricultural Education
University of Illinois
358 Education Building
Champaign, Illinois

PURPOSES OF THE INSTITUTE

The Major purposes of the UNIVERSITY OF ILLINOIS SUMMER INSTITUTE FOR TEACHERS OF ORNAMENTAL HORTICULTURE are as follows:

1. To provide teachers with an intensive period of preparation in basic ornamental horticulture and curriculum development.
2. To assist teachers in the development of a course of study and teaching plans to use in teaching introductory courses in vocational ornamental horticulture.
3. To familiarize teachers with teaching aids and student references which may be useful in the teaching of introductory, vocational ornamental horticulture courses.

ELIGIBILITY

Top priority will be given to experienced teachers who have taught or who plan to teach an introductory course in vocational ornamental horticulture at the secondary or post-secondary level. Experienced teachers who are willing to incorporate basic ornamental horticulture units into existing vocational education courses will also be considered as possible enrollees.

At least eight teachers from Midwestern states other than Illinois will be awarded Institute fellowships. Teachers who accept fellowships must be willing to field test curriculum materials in their schools and to permit Institute staff members to follow up and to evaluate the teaching of ornamental horticulture units.

APPLICATIONS

Teachers who wish to apply for an Ornamental Horticulture Institute fellowship should complete and return an application form to the Director before April 15, 1966. Requests for application forms should be sent to:

Dr. Paul E. Hemp, Director
University of Illinois
Ornamental Horticulture Institute
358 Education Building
Champaign, Illinois 61820

Applicants will be notified of action taken on their applications about May 1, 1966. Letters of acceptance from applicants and alternates must be postmarked no later than May 10, 1966. Teachers who are accepted for the Institute must file separate applications for admission to the University. Applications and necessary credentials should be submitted to the Office of Admissions and Records.

NATURE OF THE INSTRUCTIONAL PROGRAM

Participants in the Institute will enroll in Horticulture 200C, Special Problems in Ornamental Horticulture and Votec 459, Workshop in Curriculum Development. Horticulture 200C will include instruction in plant propagation, aboriculture, nursery and greenhouse management, turf management, and ornamental gardening. Votec 459 will include instruction in curriculum development, supervised practice programs, teaching aids and devices, and methods of instruction. Ornamental Horticulture 200C will meet three hours per day, five days per week and Votec 459 will meet two hours per day, five days per week. Graduate and undergraduate credit will be granted to participants who complete the course work in a satisfactory manner.

Teachers who participate in the Institute will be expected to apply what they learn to their teaching situations. Teaching plans and instructional materials developed by Institute participants and the Institute staff will be made available to teachers to use with their vocational classes during the 1966-67 school year. Members of the Institute staff will provide fol-

UNIVERSITY OF ILLINOIS COLLEGE OF EDUCATION

DEPARTMENT OF VOCATIONAL
AND TECHNICAL EDUCATION
DIVISION OF AGRICULTURAL EDUCATION

EDUCATION BUILDING
URBANA, ILLINOIS 61803
AREA CODE 217 333-0807

April 28, 1966

I am pleased to inform you that the Horticulture Institute Selection Committee has decided to award you a fellowship to the University of Illinois Ornamental Horticulture Institute. Thirty teachers from six midwestern states have been invited to participate in this research and development project.

If you accept this fellowship please acknowledge this offer by completing and returning to me the enclosed application for admission and the summer information data form by May 15, 1966. Also, you must send me a copy of an official transcript certifying your undergraduate degree. Teachers who apply for admission will receive additional information concerning the Institute program before June 1, 1966.

If you do not wish to enroll in the Ornamental Horticulture Institute this summer, please let me know as soon as possible so an alternate teacher can be invited to participate.

The Institute staff is looking forward to a challenging four weeks of work with you and other teachers. We hope the program will help us make a significant contribution to the development and conduct of vocational ornamental horticulture courses in the secondary and post-secondary schools of the Midwest.

Again, may I congratulate you for your efforts in developing new vocational programs and for being selected as a recipient of an Institute fellowship.

Sincerely yours,

Paul E. Hemp

Paul E. Hemp, Director
Ornamental Horticulture
Institute

PEH/bjf

Enclosure

COPY

April 28, 1966

The Ornamental Horticulture Institute Selection Committee has reviewed the applications for the summer institute to be held at the University of Illinois, June 20-July 15, 1966. You have been selected as one of six alternates. This means that you will be invited to enroll if any of the 30 teachers selected for fellowships decide not to participate.

As indicated in the institute brochure, top priority was given to teachers who plan to teach a separate class in ornamental horticulture in 1966-67. I appreciate your interest in the ornamental horticulture program and hope that we can share some of the instructional materials with you and other teachers who are teaching horticulture units.

Sincerely yours,

Paul E. Hemp

Paul E. Hemp, Director
Ornamental Horticulture
Institute

PEH/bjf

UNIVERSITY OF ILLINOIS COLLEGE OF EDUCATION

DEPARTMENT OF VOCATIONAL
AND TECHNICAL EDUCATION
DIVISION OF AGRICULTURAL EDUCATION

EDUCATION BUILDING
URBANA, ILLINOIS 61803
AREA CODE 217 333-0807

April 28, 1966

Your application for a fellowship to the Ornamental Horticulture Institute to be held at the University of Illinois this summer was not approved. The selection committee had to choose 30 teachers from a group of more than 60 applicants. The committee decided that first consideration should be given to teachers who have plans to teach a separate course in ornamental horticulture during the 1966-67 school year.

Even though our funds did not permit us to invite all applicants to enroll in the Institute we want you to know that we are interested in your ornamental horticulture program. I hope we can develop some useful instructional materials which we can share with you in the near future.

Sincerely yours,

Paul E. Hemp

Paul E. Hemp, Director
Ornamental Horticulture
Institute

PEH/bjf

UNIVERSITY OF ILLINOIS COLLEGE OF EDUCATION

DEPARTMENT OF VOCATIONAL
AND TECHNICAL EDUCATION
DIVISION OF AGRICULTURAL EDUCATION

EDUCATION BUILDING
URBANA, ILLINOIS 61803
AREA CODE 217 333-0807

May 17, 1966
358 Education Building

To Teachers enrolling in
the Ornamental Horticulture Institute:

Subject: Announcements and instructions
concerning registration and housing

The enclosed materials may help to answer some of the questions you have concerning the Ornamental Horticulture Institute.

Instruction will begin on Tuesday morning, June 21, at 8:00 a.m. The Ornamental Horticulture class will meet from 8:00 to 11:00 a.m., five days per week in the Floriculture Building. Votec 459 will meet from 1:00 to 3:00 p.m. in Room 33 Education Building. You will register as a group at 11:00 a.m., Tuesday, June 21.

Arrangements for University housing can be handled through Mr. R. D. Barger, 420 Student Services Building, Champaign, Illinois, 61801. In a few days Mr. Barger will send you information regarding housing facilities and food rates. You do not have to stay at the University dormitories, but I believe you will find these air-conditioned facilities to be the most comfortable and the most reasonably priced accommodations you can find near the campus.

If you have any questions or problems write me at the above address or call me at 333-3274 (Area Code 217). My home telephone number is 356-8287.

Sincerely yours,

Paul E. Hemp, Director
Ornamental Horticulture
Institute

PEH:ds
enc.

APPENDIX B

ORNAMENTAL HORTICULTURE SOURCE UNITS FOR VOCATIONAL TEACHERS

TURF MANAGEMENT

A Source Unit for Vocational Teachers

When and how to use this unit

This unit on turf management may be used with tenth, eleventh or twelfth-grade students or students enrolled in post-secondary vocational programs. Before beginning the study of turf management, students should have a background in soils, fertilizers, and plant growth. A beginning course in basic production agriculture or biology would serve as a useful prerequisite to the study of turf management. For this reason this unit on turf management should be scheduled no earlier than the tenth grade.

The first two problem areas on establishing a lawn and sodding a lawn should be taught in September. The areas on maintaining a lawn and renovating a lawn should be scheduled in May.

At least half of the instructional time spent on this unit should be devoted to field and laboratory work. This is why teachers should schedule the teaching of these problem areas during September and May.

Problem area outline

A. Establishing a lawn by seeding
   1. Deciding when to seed
   2. Preparing the seedbed
      a. Rough grading
      b. Drainage
      c. Fertilization
      d. Cultivation
   3. Selecting the seed mixture
   4. Planting seed
      a. Rates
      b. Types of seeders
   5. Covering the seed
      a. Depth of cover
      b. Mulches
   6. Caring for newly-planted seed
      a. Watering
      b. Mowing
   7. Cutting the first time
   8. Preventing lawn problems
      a. Weeds
      b. Insects
      c. Diseases

B. Sodding lawns
   1. Exploring the possibilities for using sod
   2. Deciding when and where to sod
   3. Selecting sod
   4. Cutting sod
   5. Trimming sod
   6. Cooling sod

    7. Transporting sod
    8. Storing sod
    9. Preparing the soil bed
    10. Laying sod or sod strips
    11. Watering sod
    12. Rolling and tamping sod
    13. Caring for freshly-placed sod
C. Maintaining the established lawn
    1. Selecting and applying fertilizers and lime
    2. Watering lawns
    3. Mowing grass
    4. Controlling weeds
    5. Identifying and controlling lawn insects
    6. Controlling diseases of grass
D. Renovating lawns
    1. Defining renovation
    2. Handling compaction problems
    3. Handling drainage problems
    4. Handling heavy matting or thatch problems
    5. Controlling lawn pests
        a. Weeds
        b. Insects
        c. Moles
        d. Diseases
    6. Using proper maintenance practices
        a. Watering
        b. Fertilizing
        c. Mowing

Learning outcomes

The behavioral changes which the teaching of this unit should promote are as follows:

A. To create an appreciation for a quality lawn
B. To develop the ability to identify different grasses
C. To acquire knowledges and skills in lawn maintenance necessary for employment
D. To develop the ability to perform sodding skills
E. To develop the ability to maintain lawns effectively
F. To develop the ability to identify and correct common lawn problems

Suggestions for getting started

A. Develop and give a pretest to help students become acquainted with turf management and to find out what they do not know.
B. Plan and conduct a tour of lawns to give students experience in evaluating management practices.
C. Show colored slides of poor, average, and excellent lawns. Have students identify lawn problems.
D. Conduct a discussion of the present and past experiences of students using the following lead questions:
    1. How many of you are responsible for caring for your home lawn?
    2. What do you like best about your lawn? What do you dislike?
    3. How many of you have helped establish a new lawn? How did you do it?

This discussion should lead into the next stage in the teaching process which is the identification of problems, questions, and concerns of students.

E. Use the following shock statements to start a discussion:
   1. Did you know that lawns produce more growth per acre than a hundred-bushel milo crop?
   2. Did you know that you have a hot steaming jungle in your front yard?

F. Have class discuss the contributions lawns and grass have made to society?

G. Show class a strip of sod one inch thick and a strip two inches thick. Ask them which they would rather use and why.

H. Hold up the following tools and equipment and ask class to identify them and tell their uses:
   1. Trimming frame
   2. Soil testing equipment
   3. Edgers
   4. Soil probe

I. Have students make a list of persons in the community who sell sod and a list of persons who have sodded their lawns.

J. Take a walking field trip over the school grounds. Identify areas where grass is not growing and discuss causes of poor growth.

Student references

A. Books
   1. Hoover, Norman K., Approved Practices in Beautifying the Home Grounds, The Interstate Printers and Publishers, Danville, Illinois, 1965.
   2. Musser, H. B., Turf Management, McGraw Hill Book Co., New York, New York, 1962.
   3. Schery, Robert W., The Lawn Book, The Macmillan Co., New York, 1961.

B. Pamphlets
   1. Better Lawns, Home and Garden Bulletin No. 51, USDA, United States Government Printing Office, Washington, D. C., 1964.
   2. Kemmerer, H. R. and Weinard, F. F., How to Have an Attractive Lawn, Illinois Circular 729, University of Illinois College of Agriculture, Urbana, Illinois, 1965.
   3. Lawn Diseases in the Midwest, North Central Regional Extension Publication No. 12, University of Nebraska College of Agriculture and USDA, 1963.
   4. Lawn Weeds: Identification and Control, Illinois Circular 873, University of Illinois College of Agriculture, Urbana, Illinois, 1965.

Teaching aids, equipment and materials

A. Teaching aids
   1. Turf plots in the land laboratory
   2. Slides of lawns before and after renovation
   3. Mounted weed specimens
   4. Insect specimens

5. Pictures of plant diseases
6. Slides of irrigation systems in operation
7. Chart showing the different mowing heights
8. Overlays for the overhead projectors
9. Reference books, magazines, films, film strips, pictures and charts dealing with turf management
10. Potted samples of grasses grown in the area
11. Samples of clay, loam and sandy soils
12. Samples of compacted and friable soils
13. Samples of sod with the soil washed out to show the roots

B. Equipment
1. Spades, rakes, hoes, spreaders, seeders, cutting tools, tampers, rollers and hand tools necessary for lawn work
2. Hand and power reel mowers, power rotary mower, and any other turf mowing or trimming equipment
3. Rototiller or similar implement
4. Several types of movable turf sprinklers
5. Samples of tile, gravel, and materials used locally in drainage systems
6. Percolation tubes (plastic) and pans
7. Sod trimming frame and scythe blade
8. String, stakes and identification tags for turf plots
9. Soil sampling equipment
10. Soil aerifier

C. Materials
1. Organic matter used to improve soil structure
2. Lawn grass seed
3. Liming materials
4. Fertilizers
5. Insecticides
6. Herbicides
7. Squares of sod
8. Stolons, sprigs and plugs

Laboratory exercises and special activities

A. Use the following laboratory exercises:
1. Establishing a New Lawn with Plugs
2. Turf Management Demonstration Plot
3. Turf Species and Variety Plots
4. Making Signs and Markers for Ornamental Horticulture

B. Practice lawn seeding by using a spreader and applying grass seed on a parking lot or other bare area where the seed can be swept up and reused. If grass seed is not available, a substitute such as sand or cornmeal can be used.

C. Seed a new area on the school grounds. This will give the students an opportunity to participate in all the previously mentioned lawn seeding skills and problems.

D. Provide students an opportunity to calculate the amount of grass seed and fertilizer needed for a given area.

E. Set up a demonstration of water percolation rates through samples of loam, clay and sandy soils. Demonstrate water percolation rates through compacted soils and different structured soils.

F. Provide an opportunity for each student to operate a rototiller or other suitable soil tillage equipment under field conditions.

G. Let each student figure the number of square feet in a given area of lawn on the school ground and compute the amount of sod and fertilizer required for the area.

H. Let the students cut sod strips and sod an area on the school grounds, in the land laboratory, or elsewhere in the school district. Arrange for student care for at least a month following. Use the three diagrams on sodding included in this source unit.

I. Demonstrate the correct procedure to follow in adjusting the height of cut on both a reel-type and a rotary-type lawnmower. Let the students adjust the mowers to the correct heights for mowing sodded areas

J. Set up a chemical weed control experiment to show the effect of various chemicals on common lawn weeds. Select an area with a thin stand of grass. Divide the area into ten-feet-square plots and plant common lawn weed seeds. Use several recommended pre-emergent chemicals applied in different strengths to show the effects of underapplication, correct application and overapplication on weeds and grasses.

K. Make a list of common lawn seeds found in your area. Assign each student the task of gathering and mounting several weeds. Let the students describe how to identify the weeds he has gathered to the rest of the class.

L. Demonstrate the effectiveness of water distribution of several different types of sprinklers. Explain and show the advantages and disadvantages of each.

M. Assign to each student a separate area of the school lawn to determine when to mow, when to water, and, if possible, when and how much to fertilize. Evaluate the student's ability to manage these responsibilities.

N. Have students collect soil samples. Test the soil samples and determine the fertilizer requirements for several lawns.

O. Take a field trip to nearby lawns, parks, and cemeteries to observe lawns, lawn grasses, different management practices, irrigation systems and disease and insect problems. Observe spots where sodding was done or where it would be effective. Use the Key to Lawn Disorders to analyze problem lawns.

P. Assign each student a home lawn seeding exercise or have the student renovate his present lawn if seeding is not practical.

Q. Take a field trip to a sod farm of a local sod grower.

R. Have the class set up a demonstration of poor sodding practices to use in comparing with some recommended ones. Illustrate differences in placing, watering, and maintaining.

S. Set up a public field day to discuss the results of turf management practices.

Key to Lawn Disorders

I. Irregular pattern of dead grass
  A. Turf can be rolled up like a carpet
    1. Examination reveals grubs about
       one inch below surface of grass. --- Insects --------- Grubs

- B. Turf can be pulled up easily.
    - 1. Examination reveals webby tunnels in the upper three inches of sod.--------------------- Insects----------Sod webworms
- C. On the outer edge of the dead grass the leaves of healthy plants are turning yellow.
    - 1. The entire leaf is turning yellow.
        - a. Examination reveals wireworms in the roots of the plants.----- Insects----------Wireworms
        - b. Examination of leaves reveals pinhead size red and white insects with larger black and white winged insects.----------------------- Insects----------Chinch bugs
- D. Thinning out of grass in scattered areas.
    - 1. The leaves of the infected area have brown or purple or brown with purple hardened spots on them. The spots may be round, oblong or parallel to the leaf.----- Disease----------Melting out Fade out Dying out

II. Grass blades become chewed or cut.

- A. Circular bare areas with blades and crowns chewed.
    - 1. Examination reveals worms on the grass which are over one-inch long, green with dark stripes.------ Insects----------Armyworms
- B. Grass is cut off near the soil.
    - 1. Examination reveals spotted or striped caterpillar, one and one-half to two-inches long.-------- Insects----------Cutworms

III. Round pattern of dead grass.

- A. Patches from one inch to three feet in diameter.
    - 1. Grass leaves show no lesions, are first water-soaked and dark, then dry out.---------------------- Disease----------Brown Patch Rhizoctonia Disease
- B. Patches are small, from one to six inches.
    - 1. Straw colored lesions (spots) with dark edges are found on leaves. A white cobwebby growth can be seen when dew is present.----------------------- Disease----------Dollar Spot Small Brown Patch
- C. Dead patches often following melting snow.
    - 1. A whitish pink, gray or black mold is first present then disappears leaving the grass dead.------- Disease----------Snow Mold Fusarial Patch Scald

IV. The surface of the grass blades is powdery.		
A. Reddish brown spots on surface of leaves which comes off easily. Leaves may be withered or yellow.	Disease	Rust
B. Milky white powder		
1. Leaves appear to have flour or lime on them--very powdery.	Disease	Powdery Mildew
2. Whitish moldy growth on leaves. (See IV, C 2)	Disease	Slime Mold (One variety)
C. Bluish gray to black powder		
1. Black powder in stripes with leaves turning yellow and curling up.	Disease	Stripe Smut
2. Bluish gray to black, dry, moldy growth on the leaves of the grass.	Disease	Slime Mold
V. On a new lawn, seedlings wilt and die.		
A. Predominance of tiny mottled or speckled, green, yellow or brownish gray insects that hop short distances.	Insects	Leafhoppers
B. Absence of any apparent insect population.	Disease	Damping-off Seed rot
VI. Toadstools, mushrooms, or puffballs in the lawn.		
A. In the absence of any pattern	Disease	Toadstools Mushrooms Puffballs
B. Appear in dark green grass in an arc or circle (See VII A).	Disease	Fairy arc
VII. Rings or arcs of dead grass with a strip of dark green grass on the outer edge.		
A. May or may not have toadstools or mushrooms in the dark green strip.	Disease	Fairy arc
VIII. Turf lacks vigor, appears off-color, bunchy and stunted.		
A. Grass blades dying back from tips interspersed with apparently healthy leaves. Roots are swollen, shallow and stubby.	Disease	Nematodes
IX. Miscellaneous causes of poor turf.		
A. High incidence of yellowing, stunted growth.	Possibly	A nutrient deficiency or iron or nitrogen
B. Burned areas in spots or streaks on the entire areas "scorched" immediately following a chemical application.	Possibly	Chemical "burn"
C. Small brown patches resembling symptoms of brown patch.	Possibly	Caused from dog urine
D. Generally unhealthy turf with a very thick thatch of cut grass.	Possibly	Drought due to frequent light waterings which cannot penetrate the thatch.

Study questions and answers

A. Establishing a lawn by seeding

1. What is the best time for seeding lawns and why?

a. Autumn seedings (mid-August to mid-September are best because:

(1) Soil is warm encouraging rapid germination.

(2) Adequate rainfall can be reasonably expected.

(3) Most lawn weed seeds will not germinate in the fall giving the grass a chance to become established.

(4) Grass will become well established before cold weather arrives.

b. Spring seeding is second choice and can usually be quite satisfactory. Advantages are:

(1) Adequate rainfall can be expected.

(2) Plenty of sun and warm temperatures are usually present.

Disadvantages are:

(1) Weeds germinate rapidly.

(2) Cold weather may cause slow germination.

c. Summer seedings are possible but not recommended. In order to be successful:

(1) Soak the seed to insure rapid germination.

(2) Water thoroughly and often to keep the ground cool and moist.

2. What is the procedure for rough grading a lawn?

a. Remove the top four to six inches of topsoil until building and subsoil operations are completed.

b. Remove all trash such as building debris, bricks, stones, and paper. Do not bury this material in the subsoil.

c. Protect existing trees from root suffocation if the new lawn will be considerably higher than the old level. Concrete or brick retaining walls are satisfactory for this purpose.

d. Using a bulldozer, tractor and blade, or any suitable earth mover, slope the subsoil away from the house not exceeding one-foot drop in 16 linear feet. (Caution: stay reasonably clear of basement walls as they are quite fragile at this stage.) A drop of one foot in 50 linear feet is usually quite adequate.

e. When ground is properly level add lime and phosphate as needed according to soil tests. Mix thoroughly.

f. Return the removed topsoil by spreading it uniformly over the subsoil to a depth at least four to six inches.

3. How can adequate drainage be provided for a lawn?

a. Surface drainage may be provided by sloping soil from the house toward draining ditches. A maximum slope of one foot in 16 linear feet is suggested. Slopes above this amount hinder mowing, encourage gulleying, and discourage water infiltration.

   b. Subsurface drainage may be provided by tiling.

4. How should the seedbed be prepared?
   a. If topsoil is especially tight, mix approximately one inch of humus into the top four inches of soil. Compost, peat, weedless manures, straw, or sawdust will be satisfactory. Ten to twenty pounds of nitrogen fertilizer to assist in the breakdown is beneficial.
   b. Add 20 pounds of phosphorous-containing fertilizer per 1,000 square feet.
   c. Lime to bring the pH to at least six. If pH is below six, add ground limestone at the rate of 100 pounds per 1,000 square feet to raise the pH level one unit.
   d. Work up the seedbed thoroughly by using any of the following equipment:
      (1) Disk and harrow
      (2) Rototiller
      (3) "Viking" leveler and clod buster
      (4) "Roseman rake"
   e. Smooth the seedbed by hand raking.
   f. Wait for a rain or sprinkle lightly to determine low spots. Fill in low spots as necessary for a smooth surface.
   g. Hand rake again for final preparation. A slightly rough surface is preferable to a very smooth surface.

5. What fertilizer should be applied?
   a. Lime to bring the pH to at least six. Adding ground limestone at the rate of 100 pounds per 1,000 square feet will raise the pH level one unit.
   b. Mix enough nitrogen, phosphorous and potassium fertilizer into the top two inches to bring the levels up to maintenance standards. In the absence of a soil test an application of ten pounds of 10-6-4 or a similar analysis to each 1,000 square feet will be adequate.

6. What are the principal kinds of grasses available and which should be included in the mixture?
   (The following chart gives the most important grasses, their common name, scientific name, and some of their general characteristics. For further information see Schery, Robert W., *The Lawn Book*, The Macmillan Company, New York, New York, 1961, p. 7-28.)

Common name	Scientific name	General characteristics
	NORTHERN SPECIES (Tennessee and Northward)	
Bentgrass	*Agrostis tenuis*	Spreads by stolons, recommended for lawns receiving better than average care, best adapted to cool regions.

Common name	Scientific name	General characteristics
Bluegrass, Kentucky	*Poa pratensis*	Widely adapted, spreads by rhizomes, grows erect from shoots, prefers full sun and neutral soil, thrives on moderate attention, varieties for selection available include: Arboretum, Park, Delta, Newport, Geary, Merion, Troy, and Windsor.
Bluegrass, Rough	*Poa trivialis*	Produces by stolons, bright green glossy leaves, shallow rooted, not traffic tolerant.
Fescue, Red	*Festuca rubra* (Varieties of red fescue include: Chewings, Creeping red, Illahee, Olds, Pennlawn, Ranier, and Trinity)	Wiry, hair-like, dark green effect, grows from a short rhizome and many tillers bunched from the crown, growth pattern similar to Kentucky bluegrass and mixes well with it, thrives on shade and poor sandy soils, requires only moderate fertilization, not suited to hot southern summers.
Fescue, Tall	*Festuca arundinacea* (Varieties include: Alta, Goars, and Kentucky 31)	Bunch grass with little or no rhizoming, rough clumpy appearance, endures neglect, useful on playgrounds and athletic fields, sturdy root system.
Redtop	*Agrostis alba*	Often used as a quick nurse grass, not a desirable lawn species.
Ryegrass	*Lolium multiflorum* (annual) *Lolium perenne* (perennial)	Quick sprouting, agressive, clumpy, not a desirable lawn grass.
	SOUTHERN SPECIES	
Bahia	*Paspalum notatum*	Course leaved, light green appearance, short stolons, leaves rolled in a bud with a nail-like ligule, thrives in sandy soils but is of low quality. Pensacola is the recommended variety.

Common name	Scientific name	General characteristics
Bermuda	*Cynodon dactylon* (Varieties include: Bayshore, Bradley, Everglades, Ormond, Texturf, Tiffine, Tiflawn, Tifgreen Sunturf, and U-3)	Spreads by stolons, gives a soft, dense, low, dark green appearance, intolerant to shade, attractive quick growing lawn grass when properly cared for.
Buffalo	*Buchloe dactyloides* (Varieties include: Ft. Collins, Hays, Nebraska, and Woodward)	Stringly leaved, loose, thin, grayish green turf, produces by stolons, separate male and female plants, used in areas with low rainfall.
Carpet	*Axonopus affinis*	Coarse leaved, loose creeping effect, difficult to mow due to frequent seedheads, adapted to acid, sandy, boggy soils, unsuitable for other species.
Centipede	*Eremochloa ophiuroides*	Trailing stolons, blunt leaves folded in a bud, excellent for poor soils with minimum maintenance.
St. Augustine	*Stenotaphrum secundatum*	Too coarse for a fine lawn, suffers from chinch bugs and diseases, endures sun or shade and some salt spray, no seed available but a very cheap sod for Florida and the Gulf coast.
Zoysia (Japanese lawn grass, Manila grass, or Mascarene grass)	*Zoysia matrella* (Varieties include: Meyer, Emerald, Flawn, and Ruglawn)	Produces a tight, very resilient turf, rugged, slow growing, adapted to full sun or partial shade, off-color during cold weather, one of the best lawn grasses, very slow growing, low maintenance requirement.

7. The final selection of a grass should be based on what factors?
   a. Climatically suited to the area where it is to be grown
   b. Amount of care the grass is to receive
   c. Type of use the lawn is to receive
   d. Amount of money available, although the highest priced lawn is probably cheaper in the long run.
   e. Special purposes for which the lawn will be used such as tennis or golf putting
   f. Type of soil

8. How can the seed be planted?
   a. Plant by hand by allowing it to sift lightly through the fingers during a flick of the hand or use of a shaker-top box. Bulk may be added by mixing with an equal amount of cornmeal, vermiculite, pulverized organic materials, dry soil, sand, or fertilizer.
   b. Whirlwind or cyclone type seeder
      (1) The operator should allow sufficient overlap to feather into the adjacent strip.
      (2) Sow one-half the seed in one direction and the other half at right angles to the first to avoid skipped spots.
   c. Hopper spreaders
      (1) Very precise
      (2) Can be adjusted to light seeding rates
      (3) Advisable to sow in two halves in opposite directions
   d. Felt-like mats
      (1) Contain an even distribution of seeds
      (2) Some are impregnated with fertilizers and stimulants
      (3) Not too effective due to mat disintegration, lifting by weeds underneath, tearing, blowing, and scattering by birds.

9. What seeding rate should be used?
   a. For a fine lawn in sunny areas using Kentucky bluegrass, Merion, Delta, Park, Arboretum, or Newport alone or in combination sow two pounds per 1,000 square feet.
   b. Shady areas
      (1) Chewings or creeping red fescue 75 percent and rough-stalked bluegrass 25 percent.
      (2) Sow three pounds per 1,000 square feet.
   c. Rough temporary lawn
      Ryegrass or redtop, alone or together--two pounds per 1,000 square feet.
   d. Sandy soils
      (1) Chewings or creeping red fescue 75 percent, Kentucky bluegrass, Merion, Delta, Park, Arboretum, or Newport 25 percent.
      (2) Sow three pounds per 1,000 square feet.

10. How should the seed be covered?
   a. Cover seed lightly by hand raking or by dragging with a brush or a section of chain-link fence.

    b. Cover large seeds 1/4-3/8 inches deep and small seeds 1/8-1/4 inches deep.
    c. Firm the seeded area by rolling with a light roller or cultipacker.

11. What care should be given the grass from seeding to mowing?
    a. Mulch slopes with straw or burlap to prevent erosion.
    b. Water lightly with a fine spray twice a day to a depth of one inch. A light spray will prevent washing seed into low pockets.
    c. After seed germinates gradually increase the amount of water and decrease the frequency.

12. When should new grass be mowed?
    a. Mow when the new seeding has grown about an inch taller than its customary mowing height.
        (1) Kentucky bluegrass, three inches
        (2) Bermuda or Zoysia, two inches
    b. Mow only when seedbed is dry enough to prevent tearing.
    c. Be sure mower is sharp.
    d. Once mowing has begun it should be repeated as soon as one-half to one inch of new growth has occurred.

B. Sodding lawns

1. What are the advantages of using sod?
    a. It provides a quick turf.
    b. It is a rather safe way to protect steep slopes.
    c. It is easy to learn how to sod.
    d. Sodding can be done almost anytime of the year.
    e. It is especially adapted to spots subject to frequent use.

2. What are the disadvantages of using sod?
    a. Sodding is usually the most expensive method of establishing a lawn.
    b. In certain areas, it may be difficult to obtain good sod.

3. What time of year is best for sodding a lawn?
    a. Sodding can be done almost anytime.
    b. Late spring or early fall is usually preferred.

4. Under what conditions is sodding considered desirable or justified?
    a. When placed along sidewalks or roads as a border.
    b. When placed along the foundation of a house to prevent soiling due to splashing.
    c. To obtain a quick cover in heavily traveled paths.
    d. To patch places where erosion has started.

5. What causes lawn areas to become uneven so that smoothing and leveling may have to be done before sod is applied?
    a. Footprints and tracking by implements
    b. Burrowing by animals
    c. Erosion and deposition of soil.

6. What kinds of sod are often selected?
   a. Bluegrass
   b. Fescue
   c. Bentgrass
   d. Bermuda grass

7. What tools can be used for cutting and lifting sod?
   a. Half-moon type turf edger
   b. Several kinds of mechanical cutters that are on the market
   c. Simple knives can be used.

8. What is the recommended procedure for trimming sod?
   a. Cut the sod a foot square by two inches thick. Keep the edges straight and parallel.
   b. Place the foot-square sod with the sod side down in a guage box and trim to a thickness of an inch or an inch and one-half with a sod trimmer or cutter.
   c. When using sod-cutting machines which cut standard widths at a set depth, no trimming is necessary.

9. Why must sod that is to be held for a day or two be cooled out and kept cool?
   a. To prevent yellowing
   b. To prevent weakening during storage

10. How should sod strips be handled during loading on a truck and during transportation?
    a. Roll up the individual strips with the sod side in.
    b. Load in rows on the truck.

11. What soil bed preparation is recommended?
    a. Grade and level the soil bed.
    b. The soil bed should be prepared and amply fertilized beforehand as with any seedbed.
    c. The soil bed should be firm with the surface disturbed to a depth not exceeding a quarter of an inch.

12. How should sod be laid?
    a. If the strips of sod are rolled, unroll, place in position, and nestle one against the other. Place the strips in a staggered position.
    b. Firm into place and top dress with weed-free soil to fill in the low spots and edges.
    c. Roll to firm the sod into the soil and to mesh the strips tightly against one another.

13. Is it advisable to water sod after it is laid?
    a. Water it and the underlying soil bed thoroughly to a depth of four to six inches.
    b. Tamp lightly or roll with a medium weight roller.

14. What precautions must be taken when rolling sod that has just been placed?
    a. Too heavy a roller may cause the pieces of sod to stretch or creep ahead of the roller, causing imperfect joints between the sod strips.

b. Too heavy a roller will harden the surface of the soil bed and make it difficult for the roots to penetrate.

15. What follow-up care or attention should be given a sodded area?
    a. Water thoroughly as needed for two to four weeks until the sod is firmly knitted to the soil bed.
    b. After establishment, handle as any newly seeded lawn.

16. How quickly will sod become "knitted" to the underlying soil bed?
    a. In two weeks or a little longer.
    b. Within a few weeks it will be securely rooted to the soil bed.

17. Should soil be sifted between the squares or strips of sod and seed be sown on these narrow strips?
    a. No, a checkerboard effect is likely ro result from the new seedlings.
    b. There may be a difference in the color and texture of the sod and the new seedlings.

C. Maintaining the established lawn

1. What major fertilizer elements should be added regularly to turf?
    a. Nitrogen, phosphorus and potassium
    b. Any minor elements that are deficient in a given area

2. If 7-7-7 appears on a sack of fertilizer, what does this mean?
    a. This means the fertilizer is in a 1-1-1 ratio, or 1 part nitrogen, 1 part phosphoric acid, and 1 part potash.
    b. Similarly, a 4-8-4 fertilizer has a 1-2-1 ratio of 1 part nitrogen, 2 parts of phosphoric acid, and 1 part potash.

3. What fertilizer formula should be used on turf?
    The analysis used will depend on the character of the turf, the intensity of management, soil fertility level.

4. What are the functions of lime?
    a. It improves the physical condition of heavy soils by promoting granulation.
    b. It causes small soil particles to form aggregates of larger particles which help increase the air and moisture supply of soil.
    c. It causes soils to be more loamy in character and increases the availability of plant nutrients.

5. What are the lime requirements of grasses?
    a. Grasses vary widely in their lime requirements.
    b. The bluegrasses are very sensitive to acidity and make their best growth at a pH reaction above 6.0.
    c. The fescues and bents grow over a wide reaction range and have a much lower lime requirement.
    d. Bermuda grass produces the best turf where lime is used on moderately to strongly acid soils.
    e. Zoysia grasses grow over a wide reaction and respond only when soils are extremely acid.

6. What is the rate, time and frequency of lime application?
   a. The rate of application depends on the acidity of the soil and the needs of the grass as to pH level. Ordinarily one ton or less is applied per acre.
   b. The best time to apply lime is in late fall, winter, and early spring.
   c. The rate for hydrated lime should be under 1,000 pounds per acre, or 20 to 25 pounds per 1,000 square feet. It should not be applied following the use of ammonia fertilizers.
   d. Frequent applications should be made on acid-type soils.

7. How much fertilizer should be applied to bentgrass?
   a. Two to three pounds each of potassium and potash per 1,000 square feet should be applied annually during the period of active turf growth.
   b. Nitrogen should be applied at the rate of two to six pounds per acre during the growing season.

8. At what rates should fertilizer be applied to Zoysia grass?
   a. Apply one to one and one-half pounds of nitrogen per 1,000 square feet every six weeks during the growing season.
   b. Two to three pounds of potassium and potash should be applied per 1,000 square feet annually.

9. How much fertilizer should be applied to fescue and bluegrass?
   a. Add one and one-half pounds of nitrogen in the spring and again in the fall. Also, add two and one-half to three pounds of nitrogen in the summer.
   b. Add two to three pounds each of phosphorus and potash during the growing season.

10. How much fertilizer should be applied to bermuda grass?
   a. Add one to one and one-half pounds of nitrogen per 1,000 square feet every three to four weeks during the growing season.
   b. Add two to three pounds of potassium and phosphorus per year.

11. What types of irrigation can be used on turf?
   a. Sprinkler type irrigation
   b. Surface flooding
   c. Subsurface irrigation

12. What are the essential features of sprinkler irrigation?
   a. An adequate water supply
   b. A suitable means of providing pressure
   c. Water transmission lines of adequate capacity
   d. Efficient equipment for distribution

13. At what rate should water be applied?
   Apply water at a rate which will be absorbed by the soil.

14. How much water should be applied?
   Enough water should be applied to moisten the soil to a depth of six inches.

15. How often should water be applied?
    a. During hot weather moisture will be lost at the rate of one-half to one inch every two to four days.
    b. The water holding capacity of the soil, type of soil and its physical condition plus the weather will determine to a great degree the frequency of watering.
    c. A good rule of thumb is to soak grass to a depth of six inches at least once per week.

16. When is the best time to water during the day?
    a. When temperatures are high, the best time to water is at night or in the early morning.
    b. Water applied correctly during the day will not injure the turf.

17. How can winter drying of the lawn be prevented?
    a. Late fall applications of water should be made.
    b. This will keep the turf in good condition during the winter dormant period.

18. Why should grass be watered to a depth of six inches?
    a. This is done to promote a good vigorous root system to help combat dry periods.
    b. Shallow watering will encourage shallow root penetration, thus making the lawn susceptible to drought.

19. What are the correct mowing heights for cool season and warm season grasses?
    a. Bermuda and zoysia grass should be cut to a height between three-fourths and one inch.
    b. Bluegrass and fescue should be cut to a height of one and one-half inches in the spring and fall and two and one-half to three inches in height during the summer months.

20. How much grass should be removed at each mowing?
    a. Not more than one-fourth inch per mowing.
    b. When greater than one-fourth inch is removed, the grass may be shocked and a clipping disposal problem will be created.

21. Why should clippings be removed from lawns?
    a. Clippings will choke grass and may cause thinner strands to form.
    b. They also form a mat that is more difficult for water to penetrate.

22. What are the two types of lawn weeds?
    a. Grass-type weeds
    b. Broadleaf weeds

23. What are some poor maintenance practices which promote weed growth?
    a. Using grass seed high in weed seed content

b. Poor watering practices
c. Poor fertilization practices
d. Improper mowing
e. Allowing thin stands of grass to remain

24. How can lawn weeds be controlled?
a. Appropriate watering
b. Using good seed
c. Regular mowing to the correct length
d. Maintaining the proper soil pH
e. Fertilizing during the growing season
f. Using herbicides
g. Controlling diseases and insects
h. Maintaining thick stands of grass

25. What are some of the weeds which may be found in lawns?
a. Dandelion
b. Buckhorn
c. Yellow rocket
d. Chickweed
e. Clover
f. Purslane
g. Spurge
h. Crabgrass
i. Goosegrass
j. Wild garlic
k. Plantain
l. Heal-all
m. Thistle
n. Black medic
o. Ground ivy
p. Oxalis
q. Coarse fescue
r. Knotweed
s. Foxtail
t. Shepherd's purse

26. What are the types of chemical weed controls?
a. Soil sterilants
b. Postemergent chemicals
c. Preemergent chemicals

27. How do insects damage lawns?
a. By feeding on foliage or roots
b. By living under the surface so as to interfere with turf qualities.

28. What are the three groups of insects that directly damage turf?
a. Those that attack the roots, such as grubs of the Japanese beetle, June beetle, and many other soil inhabiting insects.
b. Those that feed upon the foliage, like sod webworms, army worms, and cutworms.
c. The sucking insects that suck the plant juices from the leaves and stems. Chinch bugs are the most serious.

29. What precautions should one take when using poisonous chemicals?
   a. Label all containers clearly.
   b. Keep away from children and pets.
   c. Follow manufacturer's label directions and observe listed precautions.
   d. Avoid inhaling and skin contact.
   e. Keep out of eyes.
   f. Wash thoroughly with soap and water after use.
   g. Clean spray and dusting equipment after use.
   h. Do not apply when drift might cause injury to people or animals.
   i. Keep children and pets off turf until the material has been washed thoroughly.

30. What are some of the major insects and pests that affect turf?
   a. June beetles
   b. Annual white grub
   c. Leaf hoppers
   d. Cutworms
   e. Mole crickets
   f. Fruit fly
   g. Ground pearl
   h. Moles
   i. Mice
   j. Armadillos
   k. Japanese beetle
   l. Chinch bugs
   m. Sod webworms
   n. Army worms
   o. Ants
   p. Scales
   q. Nematodes
   r. Gophers
   s. Skunks
   t. Cround squirrels

31. What is the cause of most of the serious diseases in lawns?
   Fungi causes most lawn diseases.

32. What conditions promote fungus infections?
   a. Wet, humid weather
   b. Too frequent watering during dry weather
   c. Proper temperatures
   d. Damp clippings
   e. Restricted air movement
   f. Pure stands of grass

33. What are some of the common fungus diseases?
   a. Melting-out (fade-out, dying-out)
   b. Brown patch, rhizoctonia disease
   c. Dollar spot, small brown patch
   d. Fusarial patch and snow mold or scab
   e. Rust
   f. Powdery mildew

g. Fairy ring
h. Damping-off, seed rot
D. Renovating lawns
1. What is meant by the word "renovation"?
a. Dictionary meaning--to renew, make over, or repair
b. Pertaining to lawns
(1) Upgrading existing lawn areas
(2) Treatment needed to improve lawns which have deteriorated to the point where normal maintenance procedures cannot keep them in good condition.

2. What causes soil compaction and what can we do about it?
a. Cause--constant traffic, sometimes regular use of heavy mower (most severe on heavier soils and when traffic has occurred when soil was wet).
b. Prevention--build paved walks and patios where traffic is heaviest; use fescue on the play area because it stands up under heavy wear.
c. Correction--spiking, spading up and seeding, and power aerifiers.
d. Result--permits easier access of air, water and nutrients into the soil.

3. What causes poor drainage and how can we correct it?
a. Cause--low spots, considerable amount of traffic and inadequate preparation before planting.
b. Correction of poor drainage--aerification and reseeding, filling in low spots, better preparation before planting.

4. What causes heavy matting or thatch in turf and how can it be corrected?
a. Cause--grass is not mowed often enough; when grass becomes too high the stalks bend over and combine with the clippings to form a mat at the soil surface.
b. Correction--heavy hand raking or use of power veri-cutter to lift up the thatch and aerate the turf. Excess grass can be removed with a lawn sweeper. (Removing the clippings while mowing will aid in preventing thatch.)

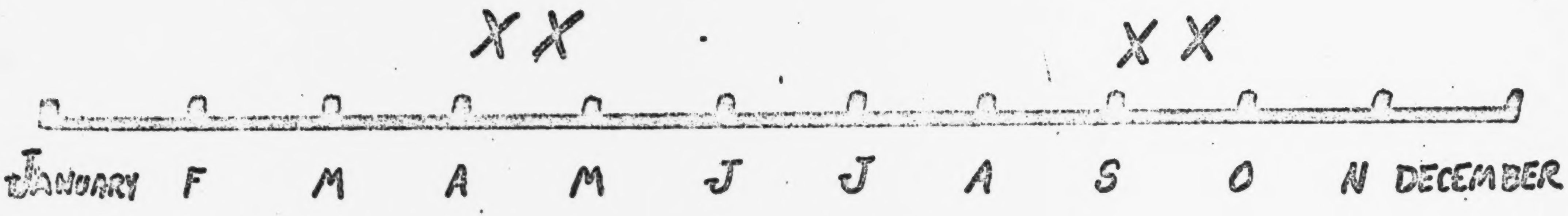
5. What are the different pests of turf and how can they be controlled?
a. Types of weeds and their control
(1) Broad leaf weeds--plantain, knotweed, creeping charlie, and clovers
(2) Narrow leaf or grass weeds--crabgrass, quack grass
(3) Use preemergence and postemergence spray.
b. Types of insects and their control
(1) Kinds of insects: white grubs, ants, wasps, chiggers, sod webworms, and earthworms. All of these pests can be killed with chlordane, dieldrin, aldrin, heptachlor, sevin or diazinon.
(2) For detailed information on insects and their control, refer to section entitled "Key to Lawn Disorders."

c. Moles and mole control
(1) Cause--numerous insects and earthworms present in the soil.
(2) Prevention--traps (best immediate control).
d. Types of diseases and their control
(1) Kinds of common diseases: rust, various leaf and stem spots, powdery mildew, slime molds and toadstools.
(2) For detailed information on prevention and cure of diseases refer to section entitled "Key to Lawn Disorders."

6. What are some proper maintenance practices used in watering, fertilizing and mowing turf on renovated areas?
a. Watering
(1) If on new renovated area with new seed, water immediately after seed is rolled. Use only enough water to moisten the upper inch of soil.
(2) When soil is dry after seeding, water once a day until two weeks after the seed germinates, then water less often, but use more water each time.
b. Fertilizing
(1) Apply 10 to 20 pounds of 10-6-4 fertilizer to each 1,000 square feet.
(2) A soil test will tell you how much lime to apply.
c. Mowing--mow the lawn when the old grass reaches a height of two and one-half inches regardless of height of the new grass.

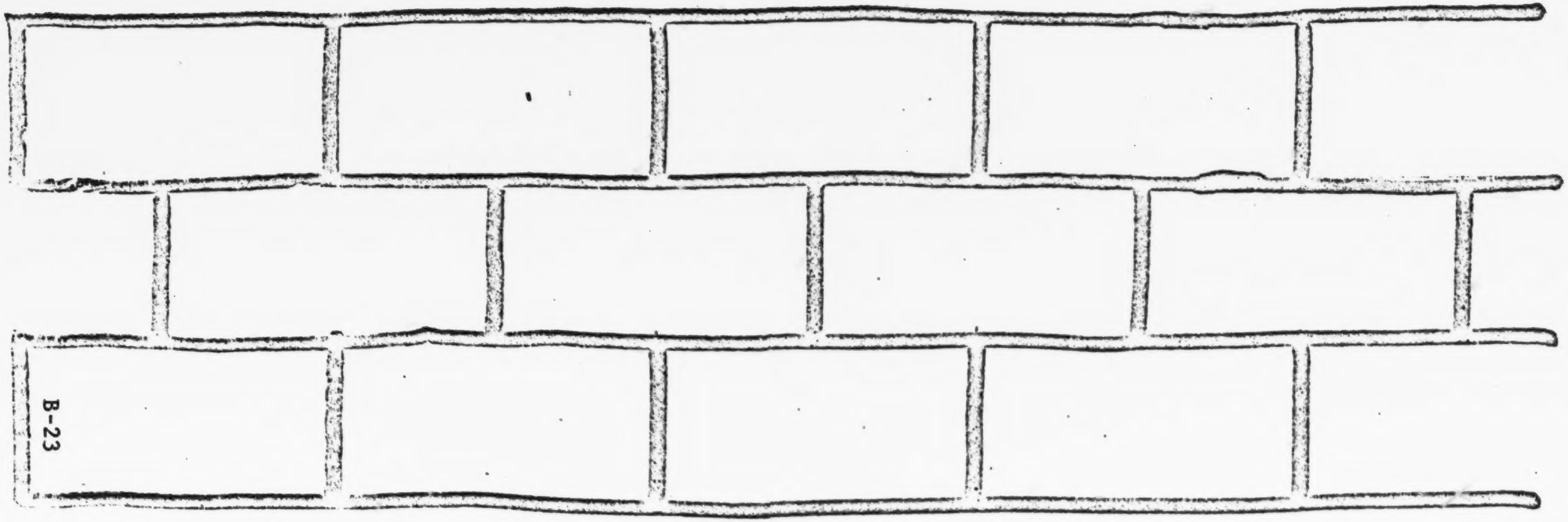
7. What are some varieties which can be used in the Midwest and varieties which can be used in shady areas?
a. Cool season grasses that are grown in the Midwest
(1) Kentucky Bluegrasses (Poa Pratensis)
(a) Common (Composite of types)
(b) Merion (25 percent of total grass in Illinois)
(c) Park (dark green, fast germination)
(d) Delta
(e) Newport
(f) Arboretum

(2) Fescues (festuca)
Red fescues (festuca Rubra) good for shade, sand and drought areas.
1. Chewing rescue--has bunchgrass
2. Pennlawn
3. Creeping red fescue
(3) Bentgrass
(a) Colonial
(b) Creeping
(c) Penncross
(d) Arlington
(4) Ryegrass
(a) Annual
(b) Perennial
b. Warm season grasses
(1) Zoysia
(2) Bermuda



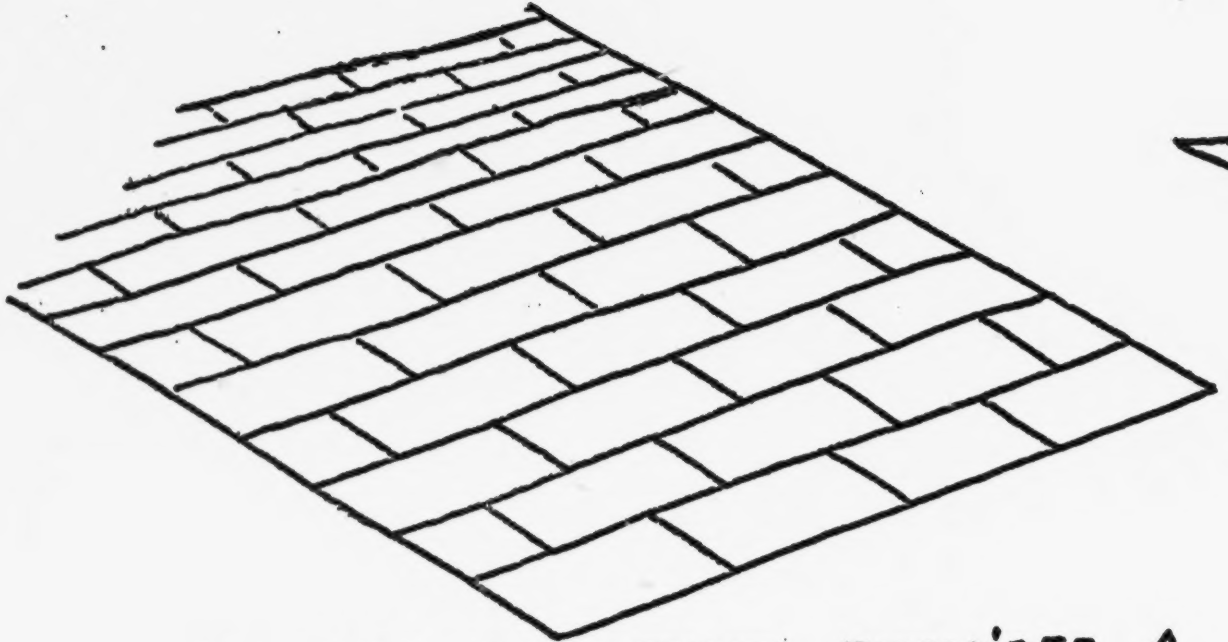
When to Sod in Illinois

Prepared by Caroll G. Johnson, Vocational Agriculture Teacher, Payson, Illinois

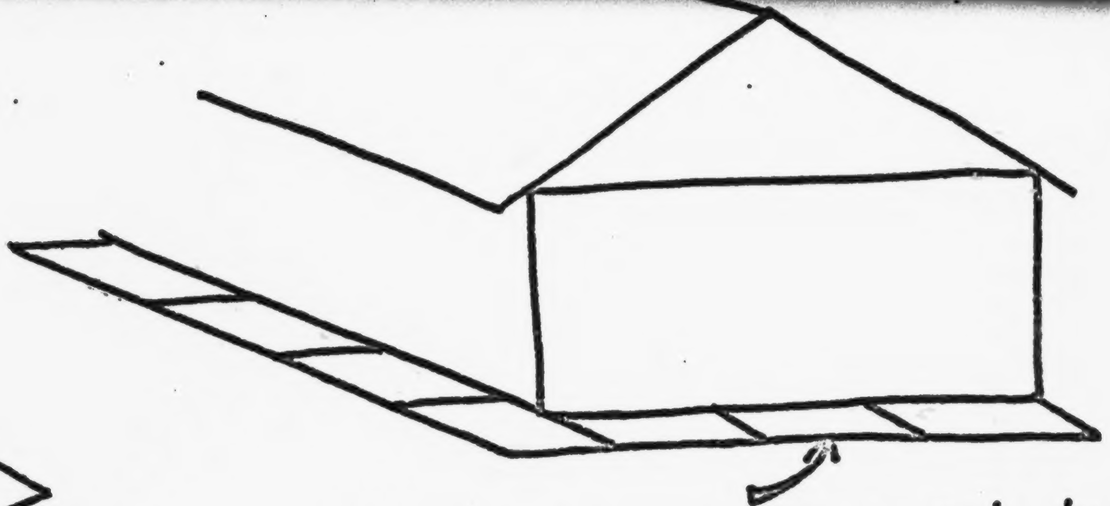


PATTERN FOR LAYING STRIPS OF SOD

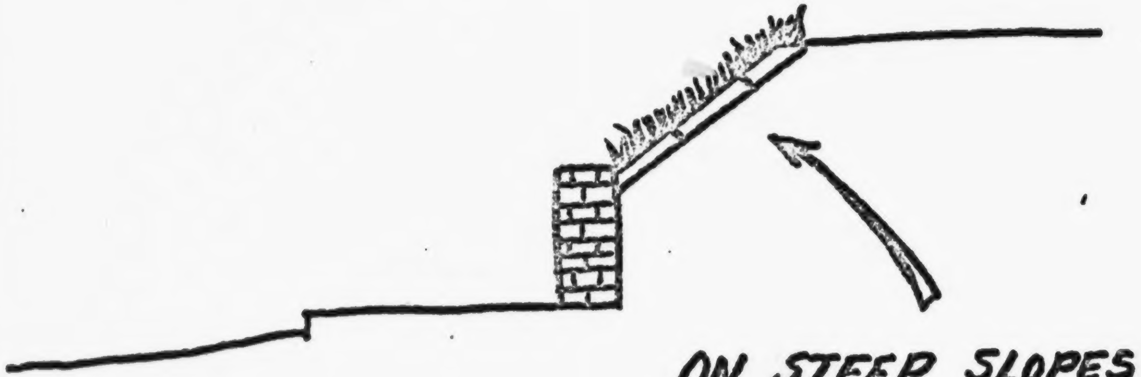
Prepared by Caroll G. Johnson, Vocational Agriculture Teacher, Payson, Illinois



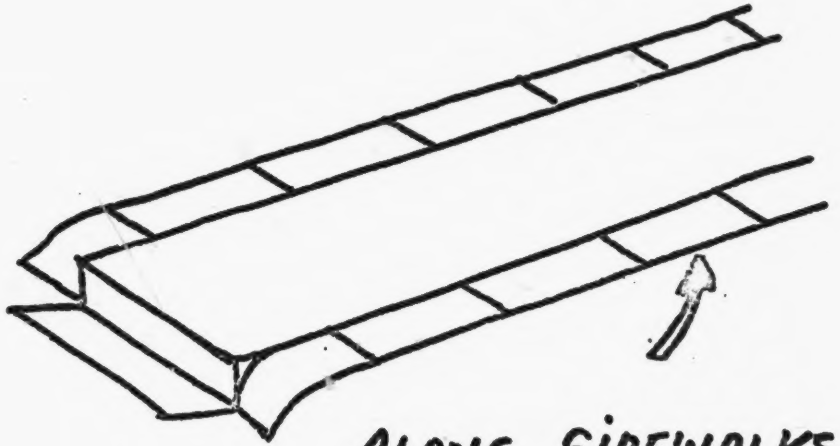
ON ANY AREA THAT REQUIRES A QUICK COVERING OF TURF



ALONG FOUNDATIONS OF BUILDINGS TO PREVENT SPLASH OF DIRTY WATER ON FOUNDATIONS DURING RAINS.



ON STEEP SLOPES



ALONG SIDEWALKS

Where to Sod ?

Prepared by Caroll G. Johnson, Vocational Agriculture Teacher, Payson, Illinois

PLANT PROPAGATION

A Source Unit for Vocational Teachers

When and how to use this unit

This unit on plant propagation includes four problem areas. All of these problem areas should be taught in the introductory or beginning course of an ornamental horticulture program. How far a teacher takes his class in the study of plant propagation will depend on the students' backgrounds, abilities, and occupational goals. Students should have a background in botany, biology, or general science before studying this unit. Since some of the material covered in this unit is commonly included in biology courses, the teacher should correlate his teaching with that of other science teachers. In a vocational program, the applied aspects of propagation are of primary concern to students.

This unit can be taught any month of the year in schools where propagating facilities are available. The preferred time for teaching the unit is during the season when students can perform propagating practices in the field. Of course, many of the propagation exercises can be performed in a greenhouse during the winter months.

Problem area outline

A. Studying plant growth and development (plant processes)
   1. Photosynthesis
   2. Assimilation
   3. Respiration
   4. Transpiration
   5. Translocation
   6. Digestion
B. Propagating plants asexually
   1. Clone propagation
   2. Propagation by cuttings
      a. Root cuttings
      b. Stem cuttings
      c. Leaf or leaf bud cuttings
   3. Layerage
   4. Propagation of bulbs and related forms (modified stems)
   5. Grafting and budding
C. Propagating plants sexually
   1. Definition of sexual reproduction
   2. Parts of the flower and their functions
   3. Types of flowers
   4. Pollination and fertilization
   5. Definition of terms

D. Selecting and using plant growth and substances
  1. Types of growth substances
    a. Hormones
    b. Regulators
    c. Auxins
  2. General uses of growth substances
  3. Using root hormones
  4. Using gibberellic acid
  5. Using fruit-setting compounds
  6. Using growth retardants
  7. Using weed controls

Learning outcomes

In developing teaching plans for these problem areas, teachers should include the content and provide the learning experience which contribute to the following learning outcomes:

1. To develop an understanding of how a plant grows.
2. To develop the ability to relate the principles of plant growth to the solution of everyday problems in plant production.
3. To develop an understanding of the influence of environmental factors on plant growth.
4. To develop the ability of students to propagate plants by various methods.
5. To develop the ability to select and apply plant growth regulators.

Suggestions for getting started

1. Show the students healthy specimens of chrysanthemums or geraniums which have been grown in controlled environments.
2. Take a field trip to a greenhouse to find out how environmental conditions affect plant growth.
3. Discuss the importance of asexual propagation in relation to the survival of certain plants in the plant kingdom.
4. Ask class how certain plants reproduce. Use examples of plants which may be propagated by each of the methods which are included in this unit.
5. Prepare a display of plant growth substances.
6. Display geraniums or other plants which have and have not been treated with growth substances.
7. Conduct a discussion to see what students know about plant processes, propagation, and growth substances.
8. Visit a nursery and show class how plants are propagated.
9. Involve class in simple propagation exercises early in the teaching of this unit.

Student references

A. Books
  1. Laurie, Alex and Ries, Victor H., Floriculture Fundamentals and Practices, McGraw-Hill Book Company, Inc., New York, New York, 525 pp., 1950.

2. Mahlstede, John P. and Haber, Ernest S., Plant Propagation, John Wiley and Sons, Inc., London, 413 pp., 1965.

B. Pamphlets

1. Butler, J. D. and Gartner, J. B. Plant Regulators; Their Use As a Hobby, Circular 836, University of Illinois, College of Agriculture, Cooperative Extension Service, April 1964.

Teaching aids, equipment and materials

A. Teaching aids

1. Films

a. Multicellular Plants-Regulation of Plant Growth, Biological Science Series, 27 minutes color.

b. Growth of Flowers, Audio-Visual Aids Service, Division of University Extension, University of Illinois, Urbana, Illinois, 9 minutes, color.

c. Growth of Seeds, Audio-Visual Aids Service, Division of University Extension, University of Illinois, Urbana, Illinois, 14 minutes.

d. Photosynthesis, Audio-Visual Aids Service, Division of University of Illinois, Urbana, Illinois, 15 minutes, black and white.

e. Photosynthesis and Respiration Cycle, Audio-Visual Aids Service, Division of University Extension, University of Illinois, Urbana, Illinois.

f. Multicellular Plants - Role of the Green Plant, Audio-Visual Aids Service, Division of University Extension, University of Illinois, Urbana, Illinois.

2. Filmstrips

a. Growth and Reproduction, NASCO, Fort Atkinson, Wisconsin

3. 8 mm film loops

a. Regulation of Plant Development, NASCO, Fort Atkinson, Wisconsin

b. Flowers and Trees-Bud to Blossom, NASCO, Fort Atkinson, Wisconsin

B. Equipment

1. Climatarium or other plant-growing facility
2. Tweezers
3. Small sharp pointed scissors
4. Magnifying glass (10-15 power)
5. Camel hair brush
6. Small containers or nails
7. Rubber bands or soft wire
8. Paper or cellophane bags
9. Flower model and charts
10. Flannelgrams showing plant processes such as:
    a. Photosynthesis
    b. Respiration
    c. Transpiration
    d. Translocation

C. Materials

1. Growth retardants
    a. B-9
    b. Cycocel
    c. Phosphon
2. Rooting hormones

Laboratory exercises and special activities

A. Use the following laboratory exercises:
    1. Overgrowth induced by application of chemicals
    2. Air layering
    3. Softwood cuttings
    4. Simple layering
    5. Bud and cleft grafting
    6. Germinating seeds
    7. Effect of oxygen deficiency and excess oxygen on germination of seeds

B. Force a potted chrysanthemum into bloom at a definite time by controlling environmental factors.

C. Force a poinsettia into bloom at a definite time by controlling environmental factors.

D. Demonstrations
    1. Potting and bedding rooted cuttings
    2. Grafting techniques
    3. Budding methods
    4. Scooping, scoring, and coring of hyacinth bulbs
    5. Pinching mums
    6. Preparing media for new cuttings

E. Using gibberellic acid:
    1. Treat geranium blossoms with gibberellic acid before they open and when the color is just beginning to show. Observe differences in size and color between treated and untreated plants.
    2. Treat tomato plants at weekly intervals from the five-leaf stage until they bloom. Notice the differences between treated and untreated plants.
    3. Use plant experiments with gibberellic acid to show its capability of manipulating the physiological responses in plants.
    4. Use seed experiments with gibberellic acid to observe the effects of seeds treated with different concentrations.

F. Using fruit-setting compounds:
    1. Tomatoes respond well to treatment with fruit-setting compounds. Grow tomatoes indoors or make a few especially early indoor plantings for later transplanting. Leave a few plants untreated so the effectiveness of treatment can be evaluated.
    2. Emasculation of the flower may be useful in determining whether fruit set was due to natural pollination or to the fruit-setting compound.
    3. The blossoms of blackberries, strawberries, squash, and other plants can be treated and the fruit checked for earliness of development, size, and presence of seeds.

G. Using growth retardants:
    1. Retardants are rather easy to use. Many experiments are possible, working with different plants, application rates, and chemicals.
    2. Pots of tall varieties of petunias or zinnias could be drenched or sprayed with different amounts of a retardant. Generally it is best to add the chemical after the plant is well established, rather than at the time of seeding or at the seedling stage.

H. Weed controls:
   1. Apply 2,4-D as recommended to a lawn infested with broadleaf weeds such as dandelions and plantains. You may have a control plot or adjoining lawn area untreated to observe the differences between treated and untreated areas.
   2. Other experiments may be conducted to note changes in structure or growth caused by 2,4-D. A few seedling tomatoes may be treated with different amounts of 2,4-D and growth modifications noted. Very low concentrations of 2,4-D might be tried on bean plants to see if plant size is increased.

I. Propagate and grow plants for use in the school office, library or cafeteria as means of creating interest in ornamental horticulture.

Study questions and answers

A. Studying plant growth and development (Plant processes)

1. What plant processes are involved in plant growth and development?
    a. Photosynthesis
    b. Assimilation
    c. Respiration
    d. Transpiration
    e. Translocation
    f. Digestion
    g. Reproduction

2. What is photosynthesis?
    Photosynthesis is the process by which green leaves of plants, in the presence and with the aid of sunlight, manufacture sugars and starches (food which makes plant growth possible) from the carbon dioxide absorbed from the air and water and raw food materials taken in by the roots from the soil.

$$6CO_2 + 12\ H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

$$\text{Carbon Dioxide} + \text{Water} \xrightarrow{\qquad\qquad} \text{Glucose Sugar} + \text{Oxygen} + \text{Water}$$

3. What main factors are involved in the process of photosynthesis?
    a. Light
    b. Temperature

4. Why is light essential for photosynthesis?
    a. Light, in the presence of chlorophyll, is the vital energy source of photosynthesis.
    b. If plants are subjected to dim light or darkness, they cannot manufacture sugar and starches. The plants will develop long weak stems, lose their green color and eventually die.

5. What other factors of plant development are affected by light?
    a. Germination
    b. Tuber and bulb formation
    c. Flowering
    d. Sex expression
    e. Direction of growth

6. How is light measured for plants?
    a. Light is measured with a light meter in candle foot power.
    b. Readings are taken at the top of the growing plant.

7. Why does exposure to intense sunlight hinder photosynthesis?
    a. Light intensity on summer days may be in excess of 10,000 foot candles and the plant being grown may require only 5,000 foot candles. Photosynthesis of this plant may stop at this excessive light intensity.

b. Plants may be grown as well or better if placed in shade during the time of high light intensity.

8. What effects do long periods of cloudy weather have on plants?
   a. Light intensity is reduced below the maximum amount of foot candles of light to carry on maximum photosynthesis in the plant growth.
   b. Temperature has to be changed somehow as light intensity changes.
   c. Chlorophyll does not develop which reduces photosynthesis and plant growth.
   d. Plants may bend towards the source of light caused by enlargements of cells on the shady side of the plant.
   e. If the light is not at the required foot candles for several days at a time, the total day length is shorter than is required. Food production is seriously reduced. Adverse effects on quality and quantity of flowers and growth may be the result.

9. What is photoperiod?
   a. Photoperiod is the daily light period or the length of light available to the plant each day.
   b. Photoperiodism is the effect of the light period on the development of plants.

10. Of what value to the plant grower is the knowledge of photoperiod?
    a. He must know the light requirements of plants.
    b. He must understand how photoperiod changes affect plant growth and flowering.
    c. Chrysanthemums and snapdragons are examples of plants which can be forced into flowering by changing the photoperiod.

11. What plant processes does temperature influence?
    a. Respiration
    b. Part of the photosynthetic reaction
    c. Maturation and ripening
    d. Dormancy
    e. Flowering
    f. Fruit set

12. What effect does temperature have on plant growth?
    a. Temperature influences the rate at which plant processes occur.
    b. High temperature increases enzymatic activity and speeds up photosynthesis.

13. What effect does the atmosphere have on plant growth?
    a. Air is not usually considered a limiting factor in plant growth.
    b. Normally the air provides sufficient carbon dioxide in relation to available light. In greenhouses, where the natural light intensity is very high, the addition of carbon dioxide to the air may be necessary for optimum production of certain plants.

14. When is the carbon dioxide level most critical in greenhouse production of plants?
During the winter it is possible that the carbon dioxide level in the greenhouse may be less than normal. This may limit the rate of photosynthesis.

15. How does the quality of the air affect plant growth?
Factory gases and smoke which contain partially oxidized hydrocarbons are detrimental to photosynthesis and to plant growth.

16. What is assimilation in plant process?
Assimilation is the process of incorporating digested material into the plant structure.

Plants, like animals, must assimilate required growth materials within their cells. Starches may be assimilated from sugars by removing water $2\ C_6\ H_{12}\ O6\ O\ H_2O$ ___ $C12\ H_{22}\ O_{11}$ (starch). This is just one example of assimilation. There are many nutrients assimilated in plants for many purposes.

17. Why is respiration important in a plant?
Respiration is the process of oxidation of sugar with the release of energy. In order to get enough energy to push up stems, open buds and leaves, or lift up limbs a plant needs a source of energy. This source is the oxidation of sugars. Respiration is the taking in of oxygen through the leaves to carry on this process. It is a continuous process.

18. How does transpiration affect a growing plant?
The evaporation of water from a leaf is called transpiration. Transpiration aids in cooling the plant by creating a pressure to pull liquids and salts through the plant as needed and prevents the accumulation of excess water within the plant cells.

19. What effect does translocation have on a growing plant?
Translocation of digested plant food materials are triggered by enzymes produced within the plant. This translocation of materials from one part of the plant to another, such as leaf to stem to flower to seed is essential to plant growth and development.

20. How does a plant carry on digestion?
Every cell within a plant is a complete unit within itself. The cells have the ability to produce the many enzymes required for digestion within the cells of the plant.

21. What effect does environment have on the plant process of reproduction?
The whole process of flowering is controlled (triggered) by the effect of light and temperature. The wrong combination of these environmental factors may keep the plant in a vegatative state and not allow it to reproduce.

B. Asexual propagation.

1. What is asexual plant propagation?
   Asexual plant propagation is promoting of growth with a part or parts of a plant which will develop a plant identical to the parent plant.

2. What is the fundamental difference between asexual and sexual plant propagation?
   a. Sexual propagation is reproduced by seed. Asexual propagation is reproduced by vegetative methods.

3. What are the reasons for vegetative propagation?
   a. Inability of some plants to produce viable seed.
   b. Inability of seeds to produce plants true to type.
   c. A particular form of plant may be perpetuated.
   d. Production of a variety may be increased.
   e. Immunity to pests can be developed.
   f. Habit of growth of a plant or plants can be modified.

4. What group of plants would you definitely recommend to be propagated asexually?
   Heterozygous plants that do not reproduce "true to seed" or to some characteristic of the parent plant.

5. Why do we have so many asexual methods of propagation?
   Many plants will reproduce only by using certain parts of the plant. A particular stock or part must be used for propagation.

6. What is a clone?
   A clone is a group of plants derived by vegetative propagation from one original plant.

7. Why is it desirable to maintain a true-type clone?
   So that all propagation stock from the clone block would come true to the parent stock.

8. What are the major types of asexual propagation?
   a. Cuttings
      (1) Root cuttings
      (2) Stem cuttings
      (3) Leaf or leaf bud cuttings
   b. Layerage
   c. Propagation of bulbs and related forms
   d. Grafting and budding

9. What is cuttage?
   Cuttage is the process of propagating plants by the use of vegetative portions cut from plants and rooting them in a suitable media.

10. What plant may be used to take root cuttings?
    Any plants that sucker easily may be propagated by root cuttings.

11. What are some examples of plants that may be used to take root cuttings?
Many ornamental plants belong in the group that lends itself to root-cutting propagation. Some examples include locust, phlox, and oriented poppy.

12. What are the three main types of stem cuttings?
   a. Softwood
   b. Semihardwood
   c. Hardwood

13. What are softwood cuttings?
Softwood cuttings are made from stems of herbaceous plants which may be started in a greenhouse with specific moisture and temperature requirements.

14. What are some examples of softwood cuttings?
Examples of softwood cuttings include geranium, carnation, chrysanthemum, petunia and coleus.

15. What are semihardwood cuttings?
Semihardwood cuttings are those taken from the current growth of shrubs and trees when the shoots snap clean.

16. What are hardwood cuttings and when should they be taken?
Hardwood cuttings are made from dormant deciduous shrubs and trees during the fall and winter. Coniferous hardwood cuttings are those taken in the fall.

17. What are leaf bud cuttings?
Leaf bud cuttings are cuttings where only the bud and leaf are taken from the plant. Usually applications of Rootone or Hormodin hastens rooting.

18. What are leaf cuttings?
Leaf cuttings are cuttings which include only the leaf.

19. What is layering?
Layering is the term given to the process of bending a branch to the ground and covering the plant just back ot the tip with 3 to 6 inches of soil.

20. What are the different types of layering?
   a. Common layering
   b. Serpentine or compound layering
   c. Pot layering

21. Why do we use layering in propagation? When do we use it on plants?
   a. Some plants do not propagate from any other asexual means of propagation.
   b. We use it only when plants are hard to graft and can be propagated by layerage.

22. What do we mean by modified stems?
Many plants persist during rest periods by means of underground buds which are carried on specialized stems and are known as bulbs, corms, rhizomes or tubers. These below-ground buds consist largely of storage tissue containing food.

23. What is a bulb?
Bulbs are short stems. They look like disks with fleshy leaf scales attached to them in continuous layers around the axis.

24. What is a corm? How does it differ from a bulb?
The corm is an underground stem with a short, fleshy, ventricle axis, sheathed with a covering of dried leaf bases. It differs from a bulb in that it is actually a solid stem with no scaly leaves and no definite basal plate. Buds form on the upper surface and root on the base.

25. What is a rhizome?
A rhizome is a stem that rises from a lateral bud close to the base of the main stem axis and extends horizontally through the soil or along the surface. A rhizome resembles a root. A rhizome is propagated by cutting the stems having buds into sections and planting.

26. What is budding and how is it used?
Budding is taking a bud from a shrub or tree and implanting it in another plant. It is used:
a. To secure better plants by means of handier and more vigorous roots.
b. To obtain large numbers of plants from a given quantity of material.
c. To permit top-working of trees.
d. To develop new plants more quickly and cheaply.

27. What is grafting? What is its purpose?
Grafting is a process of inserting one part of a plant into another in such a manner as to cause a union between the two plants. It is useful when propagating plants that fail to grow properly on their own roots either because of lack of vigor or susceptibility to diseases or pests. Other purposes of grafting are:
a. To improve the quality of foliage and flowers
b. To obtain certain shapes
c. To develop specimens sooner
d. To instill new life into old plants

28. What are the types of grafting?
a. Splice grafting
b. Side grafting
c. Saddle grafting
d. Veneer grafting
e. Flat grafting
f. Inarching
g. Cleft grafting
h. Bark grafting

- i. Whip grafting
- j. Crown grafting
- k. Bridge grafting

29. What is meant by incompatability in grafting and budding?
Incompatibility in grafting and budding is when plants will not unite because of internal factors in the scion and stock, but all other external factors are good. Such plants are not compatible and cannot be successfully grafted.

C. Sexual Propagation

1. What is the significance of the flower to the plant?
The flower is a modified stem or leaf containing the structures for sexual propagation. A flower exists to produce seed.

2. What is sexual plant propagation?
Sexual propagation involves the union of a male and female germ cell. From this union a seed, and ultimately a new plant, is produced. Sexual reproduction is a common type of reproduction for most plants.

3. Illustrate the structure of a flower with a sketch showing and naming each part. (See drawing included with this unit.)

4. What are the functions of each part of a flower?
   - a. The sepals and petals protect the pistils and stamens during the bud stage.
   - b. The stamen, which consists of the stalk and pollen sac, (filament and anther) carry the pollen grains.
   - c. The pistil consists of an enlarged base (ovary) containing ovules, a stalk leading to the ovary (style), and the terminal portion of the style (stigma). The ovary, after fertilization, develops into the fruit and the ovule into the seed.
   - d. The receptacle is the axis of the structure that bears the floral organs.

5. What are the types of flowers?
Usually a plant's reproductive organs are arranged in one of three ways:
   - a. A perfect flower contains both stamens and pistil and is the most common type of flower (tomatoes, snapdragons, and irises).
   - b. An imperfect flower contains only one type of sex organ. Those containing the pistil are called pistillate flowers; those containing stamens are called staminate flowers. Both pistillate and staminate flowers may grow on the same plant but in different places or on different plants (corn, begonias, cottonwood, and willow).

c. A composite flower is actually a cluster of small flowers called florets, joined together in what is called a flower head (zinnias, asters, and chrysanthemums).

6. How does heredity affect sexual propagation?
Plants inherit characteristics from their parents in the same way that animals do. The laws of heredity explain why different characters are inherited by offspring of the same parents.

7. What is pollination? What is fertilization?
   a. Pollination is the transfer of pollen from anther to a stigma.
   b. Fertilization is the fusion of the male and female cells. Once fertilization has occurred, development of the ovule begins. The result is a seed.

8. What is cross-pollination?
Cross-pollination is the transfer of pollen from the anther of a flower of one plant to the stigma of a flower of another plant.

9. What is self-pollination?
Self-pollination is the transfer of pollen from the anther of a flower to the stigma of the same flower or of another flower on the same plant.

10. What is the definition of each of the following terms?
   a. Anther - the part of the stamen that develops and bears pollen.
   b. Dominant - that character which when combined with the contrasting character shows up in the new plant.
   c. Egg cells - female sex cell or ovum before fertilization.
   d. Embryo - the new plant enclosed in a seed. Its formation follows union of gametes (sex cells).
   e. Emasculation - removal of stamens or anthers to prevent self-pollination.
   f. Filament - a slender stalk-like part of a stamen. It holds the anther.
   g. Gamete - either of the two cells that unite in sexual reproduction forming a new organism. A sex cell. Sometimes called germ cell.
   h. Hybrid - a plant that was produced by breeding together two different pure lines of organisms.
   i. Integuments - the outer coating of an ovule. It becomes the seed coat.
   j. Micropyle - the pore or opening through which the pollen tube enters the embryo sack during the fertilization process. A small opening in the integument.
   k. Meiosis - cell division in which whole chromosomes pair; the members of each pair separate and pass to daughter cells resulting in having the same chromosome number.
   l. Mitosis - the division of a cell in which each chromosome splits longitudinally; the halves pass to daughter cells, each of which is identical to the original.

m. Ovary - the enlarged base of the pistil in which the seed develops. It ripens to form the fruit.
n. Ovule - that structure which normally grows into the seed after fertilization. It lies within the ovary and contains the embryo sack with its egg cell.
o. Petal - leaflike part of a flower lying within the sepals; usually the part of the flower noticed first - white or brightly colored (collectively they are called corolla.)
p. Pistil - the female reproductive organ which produces female germ cells and bears the seed. Usually a pistil has an ovary, a style, and a stigma.
q. Pollen - tiny grains produced by the anther, a part of the stamen. Within each grain there is formed, besides other nuclei, the sperm nucleus which will unite with the egg nucleus.
r. Pollen tube - the tube formed by a pollen grain when it grows down the style.
s. Receptacle - the part or axis that bears the floral organs or parts.
t. Recessive - that character of a pair of contrasting characters that do not show up in the new plant.
u. Sepal - green leaflike parts forming the outer-most circle of most flowers (collectively they are called caylx).
v. Stamen - the male reproductive organ which produces male germ cells carried in pollen grains. Usually a stamen has a filament and an anther.
w. Stigma - the surface of the pistil on which pollen grains are deposited in the process of pollination.
x. Style - the elongated portion of the pistil connecting the stigma to the ovary.
y. Zygote - fertilized egg cell in plants and animals. A fertilized seed.

D. Using growth regulators

1. How and when did plant regulators get their start?

In the mid-nineteenth century, Charles Darwin conducted some experiments and observed that, in a darkened room, plants bend toward artificial light. They continued to do this when the lower parts were covered with foil, but not when the upper parts were covered. Presumably the bending was caused by something produced in the stem tip.

Other experiments by Darwin concerned geotropic responses in plants. After placing a plant in a horizontal position, he noticed that the plant soon began to bend upward. Evidently something in the plant was causing a negative gravitional attraction.

Paal determined that curvature in plants is due to an unequal distribution of a growth-regulating substance. This is learned by cutting the tip from an oat coleptile and replacing the tip to one side of the stump. The side of the stump under the tip grew more than the other side, causing a pronounced curve in the plant.

2. What are the plant growth substances?
   a. Hormones are regulators (organic substances) produced naturally by plants, which in low concentrations regulate growth and other physiological processes. Hormones usually move within the plant, from a site of production to a site of action.
      (1) Growth hormones are hormones which affect growth.
      (2) Flowering hormones are hormones which initiate or promote floral development.
   b. Regulators are substances produced artificially that modify any plant physiological process.
      (1) Growth regulators are regulators which affect growth.
      (2) Flowering regulators are regulators that affect flowering.
   c. Auxins are compounds characterized by their capacity to induce elongation in shoot cells, although auxins affect other processes besides elongation.

3. What are the general uses of plant growth substances?
   a. Encourage root growth on cuttings
   b. Stimulate grafting and wound healing
   c. Control flowering and fruit setting
   d. Hasten maturity and ripening of fruit
   e. Control leaf fall
   f. Prevent pre-harvest fruit drop
   g. Influence foliation and blossoming
   h. Thin blossoms and young fruit drop
   i. Inhibit undesirable sprouting
   j. Improve germination
   k. Control weeds

4. How do various plant species react to rooting compound treatments?
   a. Following are a few types of cuttings that usually root better after treatment. They are grouped according to relative ease of rooting.
      (1) Easy to root: camellia, carnations, chrysanthemums, coleus, English ivy, euonymus, forsythia, impatients, philodendrons, poinsettia, rose, willow.
      (2) Intermediate: azalea, barberry, currant, dogwood, holly, honeysuckle, hydrangea, juniper, magnolia, privet, quince, yew.
      (3) Hard to root: apple, fir, maple
5. How should one take and prepare cuttings for rooting compounds?
   a. Usually the youngest parts of the plant root the best. However, the effect of greater age can be somewhat overcome by using rooting compounds.
   b. Hardwood (mature) cuttings of conifers and broadleaf evergreens should be taken from October through December. Similar cuttings of deciduous trees and shrubs are usually taken during late fall or winter. The cuttings should be cut down to 6 or 8 inches and stored in a cool place until ready to root. Hardwood cuttings usually root well in the spring.
   c. Softwood or herbaceous cuttings may be taken at any time. If necessary, they may be enclosed in a plastic bag and stored at near-freezing temperatures for a few weeks before being set out.

6. How should cuttings be treated with root hormones?
Three methods of application are generally used:
   a. The most convenient method is to apply powder mixtures to the base of the cutting.
   b. Dip the base of the cutting into a concentrated solution.
   c. Soak the base of the cutting in diluted aqueous solutions.

7. What are the effects of gibberellic acid and how should it be applied?
Gibberellic acid affects the growth of plants. It increases the rate of internode growth, and helps in retaining buds. Gibberellic acid may be most easily applied as a spray.

8. Are there any undesirable effects of using gibberellic acid?
Certain undesirable effects have been attributed to gibberellic acid; no heads of lettuce, chlorosis (yellowing) in plants, legginess or excessive growth, and abnormal leaf shape and size. Results also vary according to season of the year, age of the plant, and species.

9. What is the purpose of fruit-settings compounds?
Several compounds will aid in the setting of fruit and hence the production of seedless fruit. All of them contain auxins. These substances, which are produced naturally in the plant at the time of fertilization, cause cells to enlarge and fruit to grow. When auxin is supplied artificially to plants, the fruit develops, but, as would be expected, seed is not produced unless natural fertilization has occurred.

10. What are the uses of flower control and fruit setting compounds?
Flowering control compounds may be used to induce flowering. They also may be used to inhibit or delay flower induction. Fruit setting compounds cause the fruit to set without pollination, thus preventing premature fruit drop.

11. What are the available forms of fruit-setting compounds and how are they applied?
CIPA or NOA are common fruit setting compounds. They may be applied in lanolin pastes, lanolin emulsions, vapors, aerosols, dusts, and water sprays containing the fruit setting chemical.

12. What are growth retardants?
Growth retardants are materials used to slow down the rate of growth of plants.

13. Name three common growth retardants and give examples of plants that respond.
Three of the most common materials at present are CCC (Cycocel) B-9, and phosphon. CCC and B-9 have been used successfully on poinsettias; and phosphon and B-9 on Easter lilies, chrysanthemums, and certain garden annuals such as petunias.

14. What are the effects and values of growth retardants?
Reduced plant height (shorter internodes) is the chief effect of these chemicals. They also cause some slowdown in growth, which is reflected in a longer plant life. In general, retardants improve the appearance of ornamentals by making them more compact, with darker green leaves. CCC and B-9 have recently been found to induce flowering of azaleas and rhododendrons at any time of year.

Retardants do not reduce dry weight. Nor do they change the environmental requirements of a plant. None of the retardants tried to date have affected all species.

These materials are so new that it is difficult to gauge their ultimate value. It appears, however, that they will be valuable for use with many ornamentals. Tall lilies and chrysanthemums, for example, have been shortened to satisfactory pot plants. There is also a potential use of retardants to reduce the size of trees and shrubs where they are grown in a confined space.

15. What are the methods and amounts of application for growth retardants?
Growth retardants can be obtained from garden and florist supply houses in a wide range of package sizes. Usually the smallest package should serve for experimental purposes.

CCC and phosphon generally give good results when used as soil drenches. They are less effective when applied as sprays and may even cause injury. B-9, however, is used as a spray.

For certain plants, the required amounts of specific retardant have been worked out experimentally and are given on the container. For other plants, one will have to do his own experimenting to determine optimum amounts.

a. B-9 Growth retardant
    (1) Pot-cut
        Control the height of mums and hydrangeas. For a neat dark compact plant, simply spray the foliage with the recommended diluted solution of B-9.
    (2) Annuals
        B-9 is effective in controlling height on bedding plants such as petunias, asters, marigolds, zinnias, salvias, and snapdragons. To keep Market-Pak and Jiffy Potted plants compact under crowded greenhouse and frame conditions, just spray the foliage with B-9. For petunias pour 6 oz. B-9 in empty gallon container. Add enough water to make a one-gallon solution. For other annuals use 12 oz. of B-9 to make a one-gallon solution.

b. Cycocel
    (1) Cycocel is a plant growth regulant for poinsettias. Cycocel has been tested intensively on azaleas, lilies, geraniums, camellias, and carnations, and results similar to those with poinsettias have been obtained.

(2) Dilute by adding 1 quart of Cycocel to 10 gallons of water. Apply the diluted solution as a uniform soil drench using the amounts listed in the table which follows:

Pot Diameter Inches	Fluid Ounces of Dilute Solutions per pot	1 quart of Cycocel Treats (No. of Pots)
* 2½-3	2	640
4	3	425
5	4	300
6	6	200
8	8	150

*Two applications will be necessary to apply recommended volume to 2½ inch pots.

(3) Azaleas

(a) To produce early budded, compact, symetrical plants, apply as a uniform foliar spray at the rate of 2 to 3 ounces Cycocel per gallon of water in early July when regrowth following pinching or shearing is 3/4 inch long. Repeat application one week later. Use the higher rate in the south.

(b) Do not apply Cycocel on Dawn or other Pericot varieties, as leaf injury may result. Overtreatment with Cycocel may cause temporary leaf yellowing of some varieties forced for early blooming in the greenhouse. Experience indicates that such yellowing usually disappears during storage.

(c) To control undesirable vegetative growth: When plants have reached desired head size following pinching or shearing, apply as a uniform spray at the rate of 3 ounces Cycocel per gallon of water. Repeat application one week later. Apply spray to well watered, vigorously growing plants. Foliage should be dry at time of treatment. Repeat application if rain occurs or foliage is washed within 24 hours after treatment.

c. Phosphon--The proven height retardant for pot lilies.

(1) Phosphon has been found helpful in curtailing the height of tall-growing Easter lilies such as Ace, Croft, and Georgia when grown in pots in the greenhouse. Phosphon makes compact, salable plants and does not affect the number or the quality of the flowers, or time of bloom.

(2) Apply when plants are six inches high. Punch four evenly-spaced holes into the soil to within one inch of the bottom of each pot. Mix one pint of Phosphon into 12 gallons of water, drenching each pot with eight ounces of solution. Refill the holes with soil. Water, feed and regulate temperatures as usual. Treats 180 six-inch pots.

16. What are the uses of plant growth retardants?
The use of growth retardant hormones such as MENA, the most successful growth retardant, controls sprouting in conditions that would normally induce sprouting. Bulbs can thus be stored under more varied conditions.

17. What are the effect of plant regulators as weed control?
The effect of 2,4-D on plants is not completely understood. It is active in much lower concentrations than indoleacetric acid (IAA). 2,4-D is chiefly a broadleaf weed killer. Grasses are generally resistant but a few, such as bentgrass, are susceptible. And any grass may be injured or killed if it is in the early stages of growth or if the rate of application is very high.

When 2,4-D is applied at levels too low to kill a plant, it causes several structural changes. The tip of the stem grows rapidly and this excess growth causes the tip to bend downward. The stem enlarges greatly just above the soil. Roots grow less than the rest of the plant. Very low concentrations of 2,4-D will promote growth. It has been used to root cuttings, to get better fruit set, to delay blossoming, and to reduce preharvest fruit drop. Other chemicals, however, work just as well or better for these purposes.

18. What precautions should be observed in using weed controls?
Many crop and ornamental plants are highly susceptible to 2,4-D. Among the common susceptible plants are tomatoes, grapes, and redbud trees. Spray drift has been known to damage plants as far as a half mile from the sprayed area. In some sections, 2,4-D has caused so much trouble that its use is forbidden by law.

If you use 2,4-D near susceptible plants, choose a method of application that will cause little drift or volatility of material. Under all circumstance, use extreme caution when applying 2,4-D.

The drift hazard, while always a problem, varies with a number of factors:

a. Wind. It is not wise to spray on a windy day.
b. Volatility. The ester form is quite volatile and must be used with special caution.
c. Fineness of the spray. This depends on nozzle size and pressure. The finer the material, the more the drift. Other factors, such as sprayer height, will also affect drift.

It is wise to keep a sprayer for 2,4-D only. If the same sprayer has to be used for 2,4-D and for insecticides, it should be well washed with household ammonia, sal soda, or trisodium phosphate after it has contained 2,4-D. Otherwise the residue may be a problem.

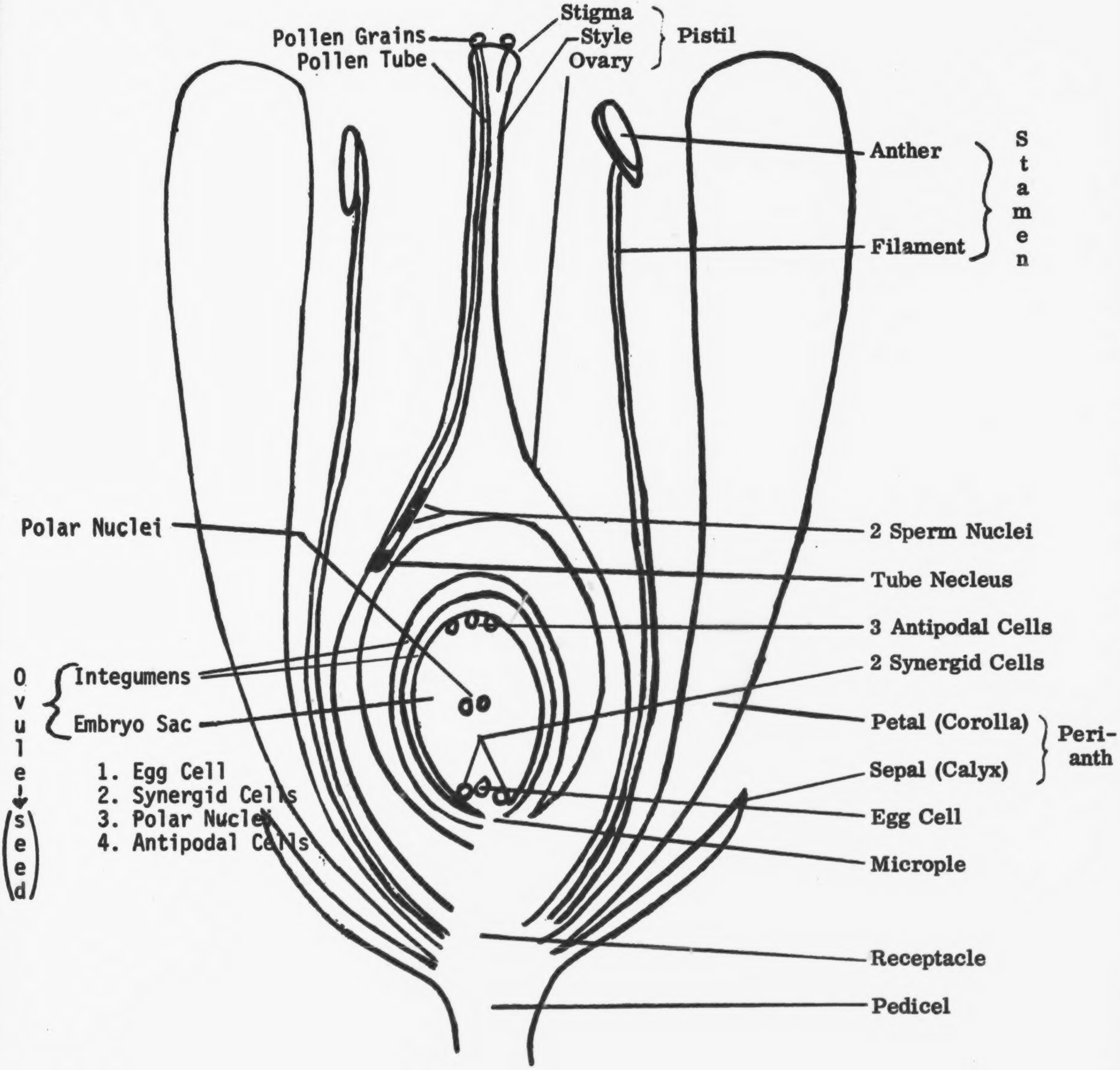
19. When and how should weed controls by applied?

Spraying is the most common method of applying 2,4-D. A small hand sprayer that covers a few square inches at a time may be used, or a large mechanical sprayer that covers several square yards.

Other methods of application include spreading granules with a lawn seeder or fertilizer applicator. A wax bar impregnated with 2,4-D may be pulled over an area. Another device has a plunger by which a measured amount of 2,4-D can be applied to a plant.

Both crops and weeds are more resistant to 2,4-D at some times than at others. As a rule, mature plants are less affected than young ones.

TYPICAL FLOWER STRUCTURE


Stigma
Pollen Grains
Style
Pistil
Pollen Tube
Ovary
Anther
Filament
Stamen
Polar Nuclei
2 Sperm Nuclei
Tube Necleus
3 Antipodal Cells
2 Synergid Cells
Integumens
Embryo Sac
Ovule
seed
Petal (Corolla)
Sepal (Calyx)
Peri-anth
1. Egg Cell
2. Synergid Cells
3. Polar Nuclei
4. Antipodal Cells
Egg Cell
Microple
Receptacle
Pedicel

GREENHOUSE MANAGEMENT

A Source Unit for Vocational Teachers

When and how to use this unit

This unit includes six separate problem areas which some teachers may not wish to teach in a continuous sequence. The first three problem areas dealing with growing mediums, soil sterilization, and transplanting may be taught in a sequence to a beginning class. The latter three areas may [illegible] taught to advanced students, who have access to a greenhouse and who can actually construct and use hotbeds, coldframes, and other structures.

Students need a background in soils, fertilizers, and plant science before they study the first three problem areas. They need prerequisites in agricultural mechanics, general science, and biology before they study the latter three areas. Students must have opportunities to actually work in a greenhouse if they are to gain anything from a study of the last three problem areas. This means that the best time to teach this unit is when opportunities are available for students to learn by doing. The entire unit should be built around class projects or individual laboratory exercises. If the recommended facilities and equipment are available, the month of the year that these areas are taught is unimportant. It is entirely possible that the teaching of this entire unit could take as long as one semester.

Problem area outline

A. Selecting growing mediums
  1. Definition of a medium
  2. Characteristics of mediums
  3. Medium components
  4. Purposes of mediums
  5. Recommended mixtures
B. Sterilizing soil
  1. Purposes of soil sterilization
  2. Preparation of soil
  3. Methods of soil sterilization
  4. Equipment needed to sterilize soil
C. Transplanting seedlings and cuttings
  1. Deciding when to transplant
  2. Potting mixtures
  3. Using additives
  4. Providing drainage
  5. Selecting containers
  6. Caring for transplants
  7. Constructing and using a potting table
D. Controlling light, temperature, humidity, and air in a greenhouse or climatarium
  1. Light control
  2. Temperature control
  3. Humidity control
  4. Air control

E. Using special structures for plant production
   1. Kinds of structures--hotbed, coldframe, lathhouse, slat house, and cloth house
   2. Uses of structures
   3. Constructing structures
   4. Maintaining structures

F. Propagating greenhouse plants
   1. Making cuttings
   2. Starting cuttings
   3. Breaking dormancy and rest periods
   4. Starting annuals from seed
   5. Controlling greenhouse insects and diseases

Learning outcomes

The specific learning outcomes which should result from this unit are as follows:

1. To develop the ability to select, mix, and use growing mediums effectively.
2. To develop the ability to sterilize soil.
3. To develop the ability to transplant seedlings and cuttings and to care for new transplants.
4. To gain an understanding of how and why light, temperature, humidity, and air should be controlled in a greenhouse or climatarium.
5. To gain an understanding of how and when various plant growing structures can be used.
6. To develop the ability to plan and build structures.

Suggestions for getting started

1. Identify two or three plant growing projects which the class would like to complete. Appropriate projects might be raising bedding plants, growing mums, or raising geraniums. Ask the class to list the jobs which need to be performed. This list should include many of the parts of this unit so that the stage is set for starting instruction.
2. Review past experiences of class by asking them the following questions:
   a. How many of you have transplanted seedlings or cuttings? How did you do it?
   b. How many of you have started annual flowers from seed? How did you do it? What results did you get?
3. Pass around samples of media and ask class to identify each sample. Make it a written exercise if you wish.
4. Ask class if they ever sterilized soil at home (areas where gas, oil, or antifreeze have been spilled).
5. Ask class if there is such a thing as clean dirt.
6. Use the following discussion questions:
   a. How do you make mums bloom at Christmas?
   b. How does light affect the growth of a plant?
   c. How does temperature affect the growth of a plant?

7. Pass around pictures of structures to the class and ask them to identify each item.
8. Illustrate or explain unusual, eye-catching, phenomena in plant production.
   a. Effects of gibberellins on stem elongation
   b. Reflex of carnivorous plants
   c. Sensitivity of certain plants (mimosa)
   d. Effects of phenomena on flower color in hydrangea

Student references

A. Books
   1. Mahlstede, J. P. and E. S. Haber. Plant Propagation, John Wiley and Sons, Inc., New York, New York.
   2. Nelson, Kennard S. Flower and Plant Production in the Greenhouse, The Interstate Printers and Publishers, Danville, Illinois, 1965.
B. Pamphlets
   1. Fosler, G. M. Germinating Flower Seeds, University of Illinois, College of Agriculture, Cooperative Extension Service, Circular No. 796.

Teaching aids, equipment and materials

A. Teaching aids
   1. Filmstrips
      a. Preparing Potting Materials, Vocational Agriculture Service, University of Illinois, Urbana, Illinois.
      b. The following filmstrips are available from NASCO:
         (1) Plant life and the soil.
         (2) Water and the soil.
         (3) Soil structure.
         (4) Soil texture.
         (5) How and why do soils differ.

   2. Films
      a. Our Mr. Sun, Bell Telephone Company, color film, 58 minutes.
B. Equipment
   1. Climatarium or greenhouse
   2. Mist system equipment for greenhouse (½" pipe, unions, elbows, and ties for ½" pipe, pipe joint compound, pipe wrenches, and pipe dies, nozzles, and one internal timer.
   3. Black cloth
   4. Incandescent and fluorescent bulbs
   5. Heat cable
   6. Propagating knives
   7. Clay, plastic and peat pots in 3½", 4" and 5" sizes
   8. Dibble boards
   9. Dibble sticks
   10. Pricking boards
   11. Label sticks
   12. Hose with sprinkle nozzle
   13. Shovels, square or #10 scoop
   14. Application equipment for Dowfume
      a. Jiffy applicator
      b. Ten-foot poly-tube

    15. Steam cleaner
    16. Oven
    17. Baking pan, 3-4" deep
    18. Thermometer
    19. Safety goggles
    20. Sprinkling can
    21. Three-gallon compression sprayer
    22. Rotary tiller
    23. Gas mask
C. Materials
    1. Plants and seeds for study of photoperiodism and plant activity in response to light and temperature
    2. Wax marking pens
    3. Grafting wax
    4. Clear polyethylene, six mil
    5. Dowfume MC
    6. Terraclor, 75 percent wettable powder
    7. Morsodren (soil drench)
    8. Vapam
    9. Pano drench
    10. Vermiculite
    11. Sphagnum moss
    12. Top soil
    13. Sand, #7 silica (plaster sand)
    14. Aggregate ¼" or more
    15. Plant food
        a. Potassium nitrate
        b. Potassium sulfate
        c. Dolomite limestone
        d. Calcium limestone
        e. Twenty percent superphosphate
        f. 5-10-5 commercial fertilizer
        g. Sodium nitrate
        h. Calcite
        i. Sulfur

Laboratory exercises and special activities

A. Use the following laboratory exercises:
    1. Transplanting seedlings to pots
    2. Mixing potting soils
    3. Effects of different media on rooting
    4. Effects of light on photosynthesis
    5. Effects of oversterilization of soil on plant growth
B. Labor-saving exercise. Set up a time-labor schedule showing the different costs for keeping a flat weeded as compared to one which has been sterilized.
C. Plant growth. Keep track of plant height as observed between the two flats. Allow one flat to be unsterilized and the other sterilized.
D. Distinguish the types of disease in soil. Select three flats. Use three different chemical fumigants. Select fumigants that control different diseases. Observe how different diseases affect the plant.

E. Compare effects of various growing media.
F. Compare effects of various types and sizes of containers on plant growth.
G. Study the effect of using unsterilized growing media.
H. Study effects of transplanting bedding plants into individual pots versus flats.
I. Study the methods of feeding and watering at the time of and immediately following transplanting.
J. Study the effects of different temperature, humidity, and light on the recovery rates of transplants.
K. Plant seeds of various depths in the same kind of medium.
L. Place five cuttings in a refrigerator for one week before planting them in a sterilized potting mixture.
M. Plant bulbs not treated with ceresan in a pot of sterilized soil. In another pot, plant untreated bulbs in an unsterilized soil mixture.
N. Study the effect of the length of day on plants.
O. Study the effect of the amount of light on stem growth of seedlings.
P. Study the effect of light on seed germination.
Q. Study the effect of light on the rooting of cuttings.
R. Study the effect of temperature on stem growth and rooting of cuttings.
S. Take students on a field trip to a commercial greenhouse to observe:
    a. Techniques of transplanting performed on a commercial basis.
    b. Automatic control of light, temperature, and humidity.
    c. Types of commercial soil sterilization techniques.
T. Place each student with a commercial grower and/or propagator for a period of time to observe and to participate in the operation of the business.

Study questions and answers

A. Selecting growing mediums

1. What is a medium?

   A medium is defined as a substance through which a force acts or an effect is transmitted; a surrounding or enveloping substance; an environment.

2. What are five properties of a good medium for propagation and growing container stock?
   - a. It must be firm enough to hold cuttings or seeds in place during rooting or germination.
   - b. It must retain adequate amounts of water.
   - c. It must have sufficient porosity to provide good drainage and adequate areation.
   - d. It must be free from weeds, nematodes and diseases.
   - e. It must have a pH level suitable for the plant being grown.

3. What are some materials that may be used as a propagating or growing medium?
   - a. Sand
   - b. Peat
   - c. Muck
   - d. Sphagnum moss
   - e. Vermiculite
   - f. Perlite
   - g. Leaf mold
   - h. Various combinations of the above

4. Why are loam soils generally unsatisfactory for starting seeds or root cuttings?

   Loam soils alone are generally unsatisfactory for several reasons. They are often heavy, poorly aerated, and have a low moisture-holding capacity, or tend to become sticky after watering. Upon drying they may shrink rapidly, forming a hard and cracked surface. Such soils draw away from the sides of the container during drying, and subsequent added water then runs down the inner sides of the container and out the drainage holes rather than rewetting the soil mass.

5. What can we do to soils to make them good propagating and growing media?

   To provide potting media with better texture, the addition of sand and some organic matter, such as peat moss or leaf mold, is usually practiced.

6. What are media mixtures?

   Media mixtures are made by mixing in desirable proportions of various substances in order to obtain a more desirable growing medium than either substance would be alone.

7. What are the basic components of the University of California soil mixture (an example of one of the most important mixes)?

   The basic components of the U. C. mixture are:
   - a. An inert type of fine sand

b. Finely shredded peat moss
c. Base fertilizer mixtures

8. How is the University of California mix prepared and used?
When using the U.C. mix, the fine sand, shredded peat moss and fertilizer base must be mixed thoroughly. Different combinations of sand and peat are used such as the following:
   a. Mixtures of 75 percent sand and 25 percent peat moss are suitable for bedding plants and nursery container stock.
   b. Mixtures of 50 percent sand and 50 percent peat are satisfactory for potted plants.

9. What is the purpose of sterilizing media, containers and tools?
The purpose of sterilizing soil is to rid it of weed seeds, nematodes, fungi and bacteria harmful to plants. To avoid recontamination of the soil, all containers and equipment must also be sterilized.

10. What are the two methods of sterilizing media?
   a. Chemicals
   b. Heat

11. What is the danger of sterilizing soil by heat?
Heating soil mixtures high in manure, leaf mold, compost and other similar materials will hasten decomposition of organic matter. This leads to the formation of toxic compounds, necessitating leaching with water and a three-to six-week delay in planting.

12. What are the conditions of an ideal media for a seedbed?
The ideal seedbed is one in which the media is moist but not wet, finely pulverized to a depth of six to ten inches, and firmed to eliminate large air spaces which increase evaporation and water loss.

13. What is a proper germinating medium?
A wide variety of materials will do the job. However, to be successful, it must be finely screened, porous, loose and open. Water must flow through the flats quickly and easily and not stand on top of it. It must be low in nutrients and salts. It must be carefully sterilized.

14. Why must caution be used to prevent contamination of the media?
It does little good to sterilize soil in the bench by any method and then contaminate it by adding untreated soil to fill the bench, adding manure or organic matter which has not been sterilized, or placing unsterilized pots or flats on the soil.

15. What are the three functions of a rooting medium?
The functions of a good medium are threefold:
   a. It provides a method of holding the seeds or cuttings in place during germination or rooting.

b. It supplies and holds water.
c. Its porosity permits aeration.

It is obvious that almost any substance can satisfy the first point, but the regulation of the water-air ratio places a limitation on many materials.

16. What is an ideal rooting medium?

An ideal rooting medium is one that provides sufficient porosity to allow good aeration, has a high water-holding capacity, and yet is well-drained. For tender softwood and semihardwood cuttings, the medium should be free of fungi and bacteria.

17. What are some media that can be used to root cuttings?

a. Sand
b. Peat
c. Shredded sphagnum moss
d. Vermiculite
e. Water
f. Moisture-saturated air

B. Sterilizing soil

1. Why are soils sterilized?

Sterilizing is a term commonly given to the process of making a soil or similar material free from all harmful organisms, weeds and insects before it is used for sowing seed or for transplanting purposes. It involves less work than the old-fashioned alternative, changing soil. If properly done, it should kill weeds and soil-borne insects and in general all of the bacteria and fungi and virus organisms that are harmful to the particular crop grown.

In addition, it makes heavy soils more granular, greatly improving drainage and aeration. This granulation often brings the greatest growth improvement of all.

2. What preparation is needed before soils can be sterilized?

The soil must be loose and easily crumbled so that it can be thoroughly penetrated by heat or chemicals. All lumps should be broken up and the heavy trash removed. The soil should be sufficiently moist to permit seed germination. Moist soil should hold its shape when squeezed in the hand. All soil amendments (such as peat, manure and other compost material and sand) must be added before treating. Do not add fertilizers containing ammonia when using soil fumigants. Next, the area is rototilled or plowed being sure to loosen the soil down to the bottom board.

3. What are the different ways that soils can be sterilized?

a. Heat treatments
    (1) Oven
    (2) Pressure cooker
    (3) Hot water
    (4) Steam
    (5) Boiling water

b. Chemical treatments
   (1) Formaldehyde (formalin)
   (2) MC-2
   (3) Dowfume
   (4) Vapam

4. What equipment can be used in sterilizing soils?
   a. Existing steam boilers.
   b. Portable oil-fired steam boilers
   c. Package steamers (steam cleaners)
   d. Chemical treatment
      (1) Pressure bomb
      (2) Hand sprayer
      (3) Sprinkling can

5. What are the advantages and disadvantages of the different methods of soil sterilization?

Treatment	Advantages	Disadvantages
Oven	1. Cheap 2. Equipment is usually available	1. Odor 2. Only small amounts can be sterilized.
Steam	1. An effective job can be done. 2. Cost is less than with chemicals	1. High initial cost. 2. Edges of the benches might not get steamed. 3. After-steaming problem. 4. Not always portable.
Chemical	1. Useful when steam is not available.	1. High cost, $400-$500 per acre. 2. Not very effective against hard-to-kill organisms. 3. A great deal of time is needed for aeration. 4. Care is needed for using certain materials. 5. Cannot be used when certain other crops are in the same area.

6. What are some problems of oversterilization and how can these problems be controlled?
   Problems:
   a. Nitrifying and other beneficial soil organisms are killed.
   b. An ammonia buildup in the soil may result. This may cause root burn.
   Control:
   a. Use high-quality, long-lasting peat.
   b. Avoid sterilization in hot water.
   c. Do not feed previous crop after it shows color, and leach it during the last watering.

d. Keep soil cultivated, encourage air penetration.
e. Do not have the soil too wet.
f. Add four pounds gypsum or 40 percent superphosphate per 100 square feet. This will help tie up the ammonia.
g. Leach heavily after steaming. Several applications must be made so that soil colloids will swell, slow down the rapid exit of water and cause wetting of all soil particles.

7. How should the different sterilization materials be used?
   a. Steam method:
   Use a canvas hose down the center of the bench. Cover the bench with an air tight material such as vinyl plastic. Heat the coolest part of the bench to 160 degrees for 30 minutes. Use a thermometer to check the temperature at several locations.
   b. Formalin:
   For each bushel of soil add 2½ tablespoons of formalin to one cup of water. Sprinkle over the surface of the soil that has been spread in a thin layer. Mix very thoroughly and place in a clean flat. Stack the flats and cover with plastic. After 24 hours you can sow the seed. Soil should be moist before treating. Air the soil until all odor has gone. For tools use one part formalin with 50 parts of water.
   c. MC-2:
   Methyl bromide is very poisonous to humans but it can be applied with complete safety. If can be used in the house where plants are growing, although slight leaf injury can occur. Sold as "Jiffy" applicator. A tight seal with plastic is necessary to prevent escape of gas. For bulky soil and pot plants use four pounds per 100 cubic feet. After treatment air soil thoroughly for three to seven days. Air sandy soils for three to four days, heavier soils three to seven days. Note: Do not use bromine fumigants for soil to be planted to carnations or salvia.
   d. Vapam (VPM):
   Apply one quart per 100 square feet with a sprinkling can or hose proportioner. With the sprinkling can distribute material evenly over the measured area. Treat only 100-200 square feet at a time. Water it thoroughly to carry the chemical through the layer to be fumigated. Do not plant for two to three weeks. After treatment make test plantings of the seeds or the cuttings. If the soil is cold or excessively wet wait three to four weeks.
   e. Mylone:
   Apply three-fourths pound per one square foot. Rototill and water with one to two inches of water. Plant after three weeks. Make test plantings. Can be dissolved in water.

f. Dowfume (W85):
   Apply three to six gallons of actual material per acre. Use either hand injector or tractor-mounted equipment. Delay planting 14-21 days.

g. Captan:
   The soil should be dry, loose and fine. Apply one-half ounce dust per square foot. Mix the dust thoroughly with the top 2½-3 inches of soil. Seed can be planted immediately after the treatment. May also be used as a soil drench, one tablespoon per gallon, at the rate of one pint per square foot. Repeat at five-day intervals if the disease persists.

Some of the important features of each of these six methods of sterilization have been outlined below:

Material	Composition	Effective for	Toxicity	Soil temperature
a. Steam	----	Weed seeds Fungi Nematodes Soil insects	None	160 degrees
b. Formalin	40 percent formaldehyde	Fungi Bacteria	Greenhouse must be empty	60 degrees
c. MC-2	90 percent Methyl bromide, two percent Chloropicrin	Weeds, bacteria and most fungi. (Verticillum is not adequately controlled.)	Slightly toxic, keep vents open	50 degrees
d. Vapam (VPM)	Liquid carbamate	Nematodes, most weeds, fungi	Toxic, empty the greenhouse	50 degrees
e. Mylone	Dry material but soluble in water	Nematodes, weeds, fungi	Toxic, empty the greenhouse	50 degrees
f. Dowfume W85	Ethylene dibromide	Nematodes, insects	Toxic, empty the greenhouse	50 degrees
g. Captan	50 percent thiram, zineb	Seed rot, seedling blight, damping-off	None	50 degrees

8. What is the difference between soil sterilization and soil fumigation?

   Soil fumigation is usually thought of as the method of soil sterilization that employs the use of chemicals. A gas is given off by this process.

9. What factors should be considered in fumigating soil?
    a. Soil temperature
    b. Soil moisture
    c. Soil texture
    d. Organic matter content
    e. Seal needed
    f. Soil type
    g. Depth of application
    h. Forms in which it can be applied
    i. Length of time needed for aeration
    j. Type of equipment needed
    k. Safety

10. Are there media materials available that do not require sterilization?
    a. Vermiculite, perlite and peat do not require sterilization. Depending on the source, sand may or may not have to be sterilized.
        (1) Vermiculite is a mineral that has been expanded by heating. It is made up of many thin alumina-silica plates held together by water molecules. The product varies greatly in size and the most acceptable grade is Number 2.
        (2) Perlite is pearl-gray in color, is a glassy volcanic lava which has been expanded artifically by heat. Perlite is not recommended for use as seeding medium. Because the product is very light in weight and will float in water, it is somewhat difficult to handle in seed flats. These materials are available at most garden supply stores.

11. What safety precautions should be observed when using soil sterilants?
    a. All insecticides are poisonous and safety precautions listed on the container labels should be followed.
    b. Store poisonous products in their original containers out of the reach of children, irresponsible persons, and pets. Lock them up if necessary.
    c. Dispose of leftover material properly and promptly. Keep from getting into ponds and streams. Protect wildlife.
    d. Dispose of empty containers so there will be no hazard to humans, animals, or plants.
    e. Never smoke, eat or chew while preparing the material.
    f. Avoid inhaling.
    g. Wear protective clothing.
    h. If symptoms of illness occur, call physician and get to the hospital.
    i. Do not use your mouth to siphon liquid from containers.
    j. Do not spray with leaking hoses or connections.
    k. Use gas mask where needed.

C. Transplanting seedlings and cuttings

1. When should you transplant young seedlings from germination flats?
   Seedlings should be transplanted as soon as they can be handled. Plants may be handled when the plants are about one inch high and the first set of true leaves is just forming.

2. How should young seedlings be handled?
   In planting, the young seedlings should be handled by their leaves. Seedlings are more easily handled this way, and there is less chance of damaging the stem.

3. What is the function of a transplanting medium?
   a. Mediums hold seedlings in place.
   b. Mediums supply and hold water. Their porosity permits adequate aeration.

4. What are some substances that may be used as transplanting mediums?
   a. Top soil
   b. Peat
   c. Sphagnum moss
   d. Sand
   e. Vermiculite
   f. Perlite
   g. Mixtures of the above

5. What soil mediums work best in potting and seedling flats?
   There are many conflicting reports on the best medium for transplanting and propagation, each type of plant having its own conditions under which it will react best. The following mixtures have generally been successful:
   a. Light soil mixtures of loam or sandy loam
   b. One part soil, one part sand, and one part peat by volume. (Perlite may be substituted for sand.)
   c. Many other variations of soil mixtures may also be used with soil substitutes such as vermiculite and perlite.

6. Why is drainage important to transplanted seedlings?
   Since water enters the plant primarily through the roots, it is necessary to have adequate water supply in the soil. However, only enough water should be provided as too much water retards root formation. This limits the water intake capabilities of the plant.'

7. How can adequate drainage be maintained in a transplant medium?
   It is unusual if a soil can be taken directly from the field and used as a potting soil. Usually some coarse organic matter or coarse aggregate must be added to make the soil porous enough for adequate drainage.

8. What type pots are most used for transplanting seedlings?
   The most used pot is usually the standard greenhouse pot which is as large in diameter as it is deep--a six-inch standard pot is six inches in diameter and six inches deep.

9. What kinds of pots are available for use and what are the advantages and disadvantages of each?
   - a. Clay pots
     - (1) Advantages
       They are porous, thus there is some exchange of air and moisture through the wall of the pot.
     - (2) Disadvantages
       - (a) Clay pots are heavy.
       - (b) Algae grow well on the outside and make the clay pot rather unsightly.
   - b. Plastic pots
     - (1) Advantages
       - (a) Light weight
       - (b) Algae do not grow on plastic pots.
       - (c) The soil in plastic pots does not dry as quickly.
       - (d) Plastic pots are easy to clean.
     - (2) Disadvantages
       - (a) Plastic is not porous.
       - (b) Overwatering is more likely in plastic pots than in clay pots.
   - c. Peat pots
     - (1) Advantages
       - (a) Both pot and plant are planted
       - (b) Eliminates the need for sterilization of pots each time they are used.
     - (2) Disadvantages
       Peat pots cannot be handled individually after potting.

10. What fertility elements are needed by seedlings and cuttings?
    Seedlings and cuttings need all the major and minor elements for maximum growth. Potting soils usually need more frequent applications of nitrogen and potash than phosphorus.

11. Why are nitrogen and potash needed more frequently than phosphorus in potting soils?
    Nitrogen and potash leach out of the potting soil much more rapidly than phosphorus.

12. How do you determine whether potting soils have enough fertilizer for optimum growth?
    The fertility of the soil should be checked with a soil test once per month or more.

13. How should fertilizer be added to potting soils?
    - a. Phosphorus and calcium fertilizers are added dry to the soil before planting because they are not highly soluble.

b. Other fertilizers are usually applied after planting either in dry or liquid form.

14. What is the pH requirements for bedding plants?
Most greenhouse plants grow best in slightly acid soil--about pH 6.5.

15. How often should fertilizer be applied to bedding plants?
Depending on size of plants, kind of weather, and method of irrigation, fertilizer may need to be applied every two to four weeks.

16. What are some of the hazards of improper watering of plants?
a. Continual light watering keeps the soil constantly wet. This limits the air supply and as a result curbs root development.
b. Too little water and uneven distribution of moisture will adversely affect root development.

17. What is meant by "gradual shift" of transplants?
"Gradual shift" is a method used in which small plants are potted only in small pots, then shifted from one size pot to the next larger size until they are finally potted in the finish pot.

18. What is meant by single shift of transplants?
Single shift of transplants is a method of starting young plants in either a two and one-fourth-inch or three-inch pot, then shifting them to the finish pot.

19. Which system, gradual or single shift, is in greatest use today? Why?
Single shift. Although the gradual shift gives the grower greater control over the environment of the plant the high labor requirement make it less desirable than the single shift.

20. What facilities are needed to perform the job of potting and transplanting?
A greenhouse bench to provide nearly level but freely draining units that can be sterilized efficiently, not be recontaminated, and be the right height and width for working with the crop.

21. What size benches may be used for ease of working when potting plants?
Pot benches are raised higher and wider than most other types of greenhouse benches. Pot plants can be worked on benches up to eight feet in width and two and one-half feet high.

22. How can equipment and materials be arranged to avoid inefficiency of operation?
For a right-handed person it is best to arrange the potting table with the rooted cuttings or plants on the left, the empty pots in front of the soil pile, and a place for the potted plant to the right.

23. What sequence of movements could be developed to obtain the greatest efficiency in potting plants?
    For small pots the pot may be filled by shoving it into the soil pile with the right hand while picking up the plant with the left. Make a hole with your finger or dibble in the soil. The plant is placed in the hole, the thumbs and forefingers of both hands are used to compress the soil on each side of the plant in one motion, and the pot is set in a flat to the right.

D. Controlling light, temperature, humidity, and air in a greenhouse or climaterium.

1. Why is light important to horticultural crops?
   Light is necessary for photosynthesis.

2. What is photosynthesis?
   Photosynthesis is the process of storing radiant energy of sunlight and a transformation of the potential energy in the manufactured carbohydrates in the leaves of plants.

3. At what intensity of light does photosynthesis take place most efficiently in many greenhouse plants?
   About 6,000 footcandles.

4. On normal summer days what light intensity can be expected? What conclusion can be drawn from this condition?
   a. Ten thousand footcandles may be generated on a normal sunny day.
   b. Thus for most efficient photosynthesis to take place, the greenhouse should be partially shaded to reduce the light intensity to an optimum level.

5. How are plants affected by extremely intense sunlight?
   Plants grown in too strong sunlight react by having short, heavy stems, small, light-colored leaves, and bleached flower colors.

6. How can you control light intensity in a greenhouse?
   By spraying a shading compound on the outside of the glass or by placing muslin, plastic screen, or tobacco cloth above the plants inside the greenhouse.

7. What light conditions may be expected in the winter?
   In many areas no more than 500 footcandles can be expected. Short days seriously reduce food production.

8. How can you get maximum light on plants during the winter?
   a. Space plants farther apart to reduce shading.
   b. Remove overhead obstacles.
   c. Clean greenhouse glass.
   d. Supplement with artificial light.

9. What is the disadvantage of artificial light?
   On a commercial basis there appears to be no economical means of furnishing enough artificial light to promote photosynthesis.

10. How does the length of day affect growing plants?
    It affects the flowering, leaf formation, leaf drop, tuber formation, fall color, and flowering of some plants.

11. What two common flowering crops are affected by day length? How?
    a. By making short days chrysanthemums can be induced to bloom. By making long days flowering can be postponed.
    b. By lengthening the daylight hours poinsettias may be delayed in flowering.

12. What is the usual relationship between light, temperature and humidity in a greenhouse? What are the implications for greenhouse management?
    Usually the more sunlight, the higher the temperature in a greenhouse. Humidity will usually decrease as the temperature increases.

    During days of much sunlight, misting and irrigation will have to be employed to reduce humidity. Increased ventilation will lower the temperature.

13. What effect does temperature have on plants?
    a. Plants grow faster in warm temperatures, but the quality of growth may not be as high as with cooler temperatures.
    b. In warmer temperatures flowers may be smaller and the color bleached or faded.
    c. Warm temperatures are desirable for foliage plants or propagation of plants.
    d. Cooler temperatures are used for holding plants dormant or developing and maturing flower buds on plants.

14. What are the usual methods of controlling temperature in the greenhouse?
    a. Summer:
        (1) Use of ventilators and fans
        (2) High pressure mist systems
    b. Winter:
        (1) Furnaces
        (2) Ventilators and fans

15. What two types of moisture conditions are important in greenhouse management?
    a. Soil moisture
    b. Air moisture

16. Why is air humidity important in a greenhouse?
    The greenhouse is usually too dry for many plants during the day in the summer. During the heating period in winter it is even drier both night and day than during the dry periods of summer.

- a. In too dry conditions:
    - (1) Transpiration may be greater than water absorption.
    - (2) Cell enlargement will not be as great.
    - (3) Plants will be shorter and the leaves and flowers will be shorter.
    - (4) Rate of growth is slower.
- b. In too humid conditions:
    - (1) Plant growth is too soft as cells enlarge more than is desired.
    - (2) Growth of disease organisms is promoted.
    - (3) The plants' resistance to diseases is lowered.

17. How can the humidity of the air be controlled in a greenhouse?
    - a. By high pressure mists.
    - b. By keeping surrounding areas such as walks and area under benches moist so as to gain moisture from evaporation.

18. What two ingredients of air are of primary importance to plant growth?
    - a. Oxygen
    - b. Carbon dioxide

19. Why is the carbon dioxide level especially critical in greenhouses during the winter?
    During the winter greenhouses are often closed for extended periods of time. Plants tend to use up the existing carbon dioxide and a deficiency will develop.

20. What are some methods that may be used to control the carbon dioxide level in greenhouses?
    - a. Apply additional carbon dioxide by artificial means.
    - b. Insure good circulation of air from outside the greenhouse.

21. How can you control air movement in a greenhouse?
    - a. Air movement is accomplished best with air circulation fans.
    - b. Ventilators and removable sidewalls are sometimes used.

22. Why is continuous air movement important?
    It provides more uniform temperature and humidity conditions throughout the greenhouse.

E. Using special structures for plant production.

1. What specialized structures are used in the greenhouse business?
    - a. Cold frame
    - b. Hot bed
    - c. Slat house
    - d. Lath house
    - e. Cloth house

2. What use is made of the special greenhouse structures?
    - a. Cold frame
        - (1) Hardens off plants
        - (2) Provides a cool environment
        - (3) Provides a cheap form of protection for growing and propagating plants.

b. Hot beds are used for germination of plants needing a less controlled environment than the greenhouse. They are less expensive than a greenhouse.

c. Slat houses, cloth houses, and lath houses provide some production but shade is an important part of their use.

3. What is a hot bed?
A hot bed is a structure that can be heated but lacks complete control over the environment.

4. What materials can be used for plant structures?
Economical building material may be used. Lumber, concrete blocks, concrete, corn stalks, straw bales and similar material may be used for the sides and ends. The covers are of glass, cloth, snow fencing, plastic (vinyl), canvas, and straw mats.

5. How may a hot bed be heated?
Some source of heat is needed for hot beds. Furnaces, stoves, boilers, electrical heating cable and decomposing manure are some of the ways of providing heat.

6. What are the common dimensions of hot beds and other structures?
   a. Hot beds are usually covered with sash measuring 3' x 4'or 4' x 6'. This sash is standard for the industry and consequently the dimensions of the beds would need to be kept in units of the sash size.
   b. The beds, both hot and cold, need to be narrow enough to tend from outside the structure thus a width of six feet would be the maximum.
   c. Hot bed sides should be at least six inches higher on the north side than on the south side to allow the sun's rays to enter. The cold bed can be even sided.
   d. The other structures will be dimensioned according to use and material.

7. How does a cold frame differ from a hot bed?
A cold frame has no source of heat other than the sun. No special means of retaining the sun's heat is used, hence the name.

8. What materials may be used for covering a cold frame?
Glass sash (3' x 4' or 4' x 6'), canvas, cloth, straw mats, boards, plastic and other glass substitutes may be used.

9. Where should cold frames and hot beds be located?
   a. Both need a well-drained location. The hot bed should extend east and west for greatest light and face the south.
   b. The cold frame may face the north if used for rooting cuttings and can face the south for growing seedlings.

10. What is the purpose of lath shades or lath houses?
These structures are inexpensive to construct and are used as growing structures in the summer time in the northern areas and year around in southern areas. Hydrangea and azaleas can be grown in them because they furnish 50 to 75 percent shade.

11. What use is made of a cloth house?
    a. A cloth house may be used for summer production or for propagation in mild climates. It protects against wind and rain. Asters and chrysanthemums are grown as cut flowers in them in mild climates.
    b. The disadvantage of a cloth house in the reduction of light.

F. Propagating greenhouse plants.
1. What are the common types of cuttings?
    a. Root cuttings
    b. Stem cuttings
    c. Leaf or leaf bud cuttings

2. When should root cuttings be taken?
    a. Fall and early winter
    b. Winter

3. How should root cuttings be handled?
    a. Fall and early winter
        (1) They should be taken by running a trencher close to the parent plants and cutting sections from exposed roots.
        (2) The roots should be sectioned into two- to seven-inch lengths, one-fourth to one-half inches in diameter.
        (3) They should be laid horizontally in shallow trenches and covered with two to three inches of soil.
    b. Winter
        (1) Cuttings are usually collected from stock specifically dug for propagation.
        (2) Plant them in flats and cover with one and one-half inches of soil.

4. What are the types of stem cuttings?
    a. Rhizome
    b. Tuber
    c. Softwood
        (1) Herbaceous
        (2) Greenwood
    d. Intermediate
        (1) Ripewood
        (2) Broadleaf
        (3) Evergreen
    e. Hardwood

5. What are the effects of time of taking softwood cuttings on root initiation?
    a. Cuttings should be taken at a time when the carbohydrates-nitrogen ratio is relatively high.

b. Rate and percentage of rooting is directly proportional to the carbohydrate-nitrogen ratio and content in the plant.

6. What is a method that may be used to determine the existence of optimum conditions for rooting?
Stems to be used are compressed between the thumb and forefinger; if the stem snaps, the tissues probably are ready for rooting; if there is no clean break or if the stem merely bends, plants are probably not ready for cuttings.

7. How should softwood cuttings be handled?
   a. Section the shoot into four- to six-inch lengths.
   b. Remove the lower leaves.
   c. Make a basal cut one-half inch below the node.

8. What factors affect firmwood cuttings?
   a. Food supply
   b. Juvenility
   c. Rooting medium

9. What types of cuttings may be used to propagate evergreens?
   a. Simple
   b. Heel
   c. Mallet

10. How is the simple method (the most important method) used to propagate evergreens?
   a. The cutting is made of the current season's growth.
   b. The foliage is removed from the lower third of the cutting.
   c. Wood should be collected from November through February.
   d. Cuttings should be from five- to ten-inch lengths.

11. What factors affect the rooting of hardwood cuttings?
   a. Food supply
   b. Sex of the plant
   c. Wounding responses
   d. Oxygen and moisture
   e. Temperature

12. How should hardwood cuttings be handled?
   a. Select moderately vigorous, well-matured, one-year-old wood containing viable buds.
   b. Shoots should be collected in the early winter, after one or two sharp freezes, but should not be frozen.
   c. Remove the base and tip of the shoot leaving the medial two-thirds of the branch three to ten inches in length.
   d. The basal cut should be made at a 45 degree slant about one-half inch below a node. A cut at right angles to the stem at the distal end should also be made.

13. What are optimum rooting media temperatures for root initiation?
For most herbaceous cuttings optimum bench temperatures for greenhouse propagation lie between 65 degrees and 70° F. with an air temperature between 55° and 60° F.

14. What are the advantages of intermittent-mist propagation?
   a. The particles of water, atomized under pressure through nozzles, form a thin layer of moisture on the leaf. These are constantly being evaporated, with a resultant absorption of heat and significant cooling effect.
   b. Water loss from cuttings is reduced and wilting is prevented.
   c. Because of the abundance of foliage which may be retained at the time of cutting placement, a greater supply of carbohydrates is available for rooting and continued growth.

15. What is the difference between dormancy and rest period?
   a. Dormancy is the failure of seeds to germinate because of any condition, internal or external.
   b. Rest period is the failure of seeds to germinate because of some internal condition.

16. How can seed dormancy or rest periods be broken to facilitate germination?
   a. Acid treatment
   b. Scarification
   c. Soaking in water

17. When should annuals be started?
Indoors, the plants may be started as early as January or February, but should not be set outside until danger of frost has passed.

18. What are the properties of a good soil medium for starting annuals?
   a. Proper aeration
   b. Adequate drainage
   c. Adequate water holding capacity

19. What type and analysis of fertilizer should be used in the seedbed?
Use a complete fertilizer, such as 5-10-5, 10-6-4, or 10-10-10 and apply at the rate of one to two pounds per 100 square feet of flowerbed area.

20. How often should newly-sowed seeds be watered?
   a. Water only as necessary.
   b. Check moisture twice a day.
   c. Use subirrigation with small seeds.
   d. Apply water gently.

21. When should seedlings be thinned?
    First thinning should be done at the time plants (seedlings) begin to produce true leaves.

22. What are some good fungicides for treating seeds prior to planting?
    a. Thiram
    b. Captan
    c. Chloranil
    d. Ferbam

23. How much fungicide should be used?
    For each ordinary seed packet, use an amount equal to about a match head.

24. Why are seeds treated with fungicide?
    Seed treatment is one important precaution against seed rot and damping off.

25. Why are some general control measures for greenhouse insects and diseases?
    a. Sterilize the soil.
    b. Use seed disinfectants such as:
        (1) Bichloride of mercury
        (2) Organic mercury compounds
        (3) Formaldehyde
        (4) Hot water
    c. Use seed protectants such as:
        (1) Copper compounds
        (2) Zinc oxides
        (3) Organic mercury compounds
    d. Use insecticides such as:
        (1) Chlordane
        (2) Dieldrin
        (3) Malathion
        (4) Carbonyl
        (5) Diazinon
        (6) DDT
        (7) Metaldehyde

26. What precautions should be followed when using pesticides?
    Always read and follow the directions given on the label.

27. Define or describe each of the following:
    a. Propagation--A means (sexual or asexual) by which the magnitude of a plant species is increased.
    b. Dormancy--Any condition, internal or external, which tends to prevent seeds from germinating.
    c. Cutting--A detached vegetative part of a plant which when placed under suitable conditions will develop into a complete plant, similar in all characteristics to the parent plant.

d. Hormone--A substance produced in one part of a plant in low concentration for use or action in another part.

e. Fungicide--A chemical compound used to kill or retard the development of fungi in or on plants.

f. Scarification--Mechanical or chemical means by which the seed coat is penetrated to allow the entrance of moisture in order to break dormancy.

g. Rest period--An internal condition that tends to prevent seed germination.

h. Auxin--A compound which increases elongation in shoot (meristematic) cells.

i. Stratification--An after-ripening period in which seeds are subjected to abundant moisture, ample oxygen, and relatively cool temperatures in order to induce germination.

j. Soil drench--A chemical compound used (often in place of steam) to kill or retard the development of fungus spores in the soil.

k. Asexual propagation--A means of increasing the magnitude of a plant species by use of vegetative parts such as roots, stems, leaves.

l. Annual--A plant that requires one growing season to complete its life cycle.

m. Germination--Emergence and initial growth of an implanted seed.

n. Biennial--A plant that requires two growing seasons to complete its life cycle.

o. Rhizome--A modified root or stem growing in a cylindrical pattern below the ground level.

p. Sexual propagation--A means of increasing the magnitude of a plant species by seeds or spores.

q. Perennial--Long lived plants that require more than two years to complete the life cycle.

r. Tuber--An underground stem or rootstock possessing several nodes and internodes.

s. Insecticide--A chemical compound used to kill or control infestations by insects.

t. Apical dominance--An effect of the suppression of the development of the axillary buds by the terminal bud.

ABORICULTURE

A Source Unit for Vocational Teachers

When and how to use this unit

Aboriculture involves the cultivation of woody plants, particularly those used for decoration or shade. The four problem areas included in this source unit are as follows:

1. Identifying trees and shrubs
2. Selecting and buying trees and shrubs
3. Cultivating and mulching trees and shrubs
4. Fertilizing trees and shrubs

These four problem areas can be taught as a unit to juniors or seniors or the problem area on identifying trees and shrubs may be taught to freshmen or sophomores. The first three problem areas should be taught in early fall or late spring when classes can participate in field exercises. The problem area on fertilizers should be taught in March or April prior to the proper time for fertilizer application.

The problem area on tree and shrub identification can be taught to beginning students in horticulture or agriculture. The latter three problem areas should be scheduled after students have received basic instruction in biology, soils, fertilizers, and plant growth and development.

Most teachers of horticulture agree that students should be required to learn the scientific as well as the common names of plants. High school students who are preparing for employment in horticultural businesses will need to know the scientific names of plants if they are to communicate with nurserymen and landscape gardeners.

Problem area outline

- A. Identifying trees and shrubs
  1. Nomenclature of trees and shrubs
  2. Classes and types of trees and shrubs
  3. Characteristics used in identification
  4. Identification by general appearance
  5. Identification through use of a plant key or guide
- B. Selecting and buying trees and shrubs
  1. Purposes for which trees and shrubs are grown
  2. Factors to consider in selecting trees and shrubs
  3. Suggested trees and shrubs which serve various purposes
  4. Grades and standards for nursery stock
- C. Cultivating and mulching trees and shrubs
  1. Purposes and methods of cultivation
  2. Types of mulches
  3. Mulching practices

D. Fertilizing trees and shrubs
    1. Five cardinal principles of plant growth
    2. Relationship of fertility to plant growth
    3. Function of plant food elements
    4. Deficiency symptoms
    5. Selection of fertilizers
    6. Application of fertilizers
    7. Special problems in fertilizing trees

Learning outcomes

The content and teaching approaches used in the teaching of these problem areas should be planned so as to contribute to the following objectives:

A. To develop the ability to identify common trees and shrubs
B. To develop the ability to select trees and shrubs for particular purposes
C. To develop the ability to cultivate and mulch trees and shrubs
D. To develop the ability to select and apply fertilizers

Suggestions for getting started

A. Give students an identification exercise to develop interest in the problem area on plant identification. Use colored slides or pictures from nursery catalogues for the identification contest.
B. Ask class members to bring in leaves from trees and shrubs raised at home. Display leaves and names of plants on the bulletin board.
C. Take a field trip to the school nursery, a commercial nursery, or to local residences to identify trees or shrubs.
D. Ask students to name a tree or shrub which is used for shade, spring flowering, fragrance, wind breaks, fall color, berries, and border plantings.
E. Show various kinds of mulching materials to class and discuss uses of each.
F. Show class examples of leaves and twigs from fertilized and unfertilized trees or shrubs.
G. Show class pictures or slides of trees or shrubs exhibiting deficiency symptoms. Explain the causes of each problem and suggest possible solutions.

Student references

A. Symonds, George W. D., *The Tree Identification Book*, New York: M. Barrows and Co., 1958.
B. Symonds, George W. D., *The Shrub Identification Book*, New York: M. Barrows and Co., 1963.
C. Pirone, P. P., *Tree Maintenance*, New York: Oxford University Press, 1959.

Teaching aids, equipment and materials

A. Colored slides of some trees in bloom in the spring and leaves as they change color in the fall of the year.
B. Samples of leaves from trees of different color to compare them for interest and beauty.
C. Samples of different grades of nursery stock. These can be kept from year to year just to show size, length, and root size.

D. Measuring equipment to measure trees and shrubs
E. Samples of mulches, moisture tester, and soil thermometer
F. Slides showing weed control by chemical means
G. 16 mm film - "The Easy Way," Control of lawn & garden weeds, Clana Products Co., Indianapolis 6, Indiana
H. Plant specimens (either in school nursery or local nursery)
I. Tags to identify leaves when drying
J. Shoe boxes
K. Cornmeal
L. Alum
M. Plastic spray
N. Nursery catalogues
O. Clipboard for each student for field trips
P. Pictures of common trees and shrubs
Q. Paper bag marked "LUNCH" with 4 oz. bottles of ammonium nitrate, treble phosphate, muriate of potash and limestone
R. Colored slides showing trees suffering from malnutrition, healthy trees, and methods of fertilizer application
S. Chart showing recommended amounts of fertilizer
T. Specimen leaves and twigs showing "die back," growth rate, leaf size, and color of both healthy trees and those suffering from malnutrition

Laboratory exercises and special activities

A. Laboratory exercises
  1. Planting a balled and burlapped tree
  2. Balling and burlapping a young tree
  3. Bracing trees and limbs
  4. Pruning mature trees
  5. Fertilizing large trees
  6. Selection of trees and shrubs for a home site:
    a. Make a drawing of a home site and yard on a sheet of paper 11 inches by 16 inches. Mark areas where trees and shrubs are to be planted.
    b. Have each student select trees and shrubs for the areas provided on the drawing taking into consideration the following factors:
      Shade characteristics
      Disease and insect resistance
      Climate and soil requirements
      Decorative value as it will fit in with the buildings and grounds
      Colors in spring and fall
  7. Determine the grade and quality of trees and shrubs
    a. Group three students together and let them develop some standards to follow in grading trees and shrubs for sale. These standards should be developed for coniferous trees and for deciduous trees.
    b. Have students compare the standards they developed with the American Nursery Association standards.

8. Identifying grades and quality of Nursery Stock
    a. Take class to nursery where students can observe trees and shrubs that have been graded for sale
    b. Let nurseryman point out characteristics and important features of stock as used by the American Nursery Association.
9. Apply chemicals to school plot.
    a. Observe weed control
    b. Observe damage to plants
    c. Observe residual effect
10. Apply mulch to school plot
    a. Observe weed control
    b. Observe growth of plants
    c. Check temperature of soil
    d. Check moisture of soil
    e. Check quality of mulch
11. Fertilize trees using Ross Root Feeder or hydraulic injector.
12. Make foliar or soil applications of chelated iron to pin oak suffering from chlorosis.
13. Determine cause of chlorosis and check effects of spray application.
14. Test soil from tree area for pH, available phosphorus, potassium, and nitrogen.
15. Make tissue test of leaves for nitrogen.
16. Rate fertilized and unfertilized trees of same species for leaf color. Score from 1 to 5 depending on shade or depth of green color.
17. Measure terminal growth of various trees.

B. Special activities
    1. Let students suggest trees and shrubs for areas on school grounds and point out problems of plantings already located.
    2. Have students select trees or shrubs for home and yard as may be needed to improve it.
    3. Take a field trip to a nursery if possible to observe quality of trees and to study grades. Students could also compare different species of trees and shrubs.
    4. Figure application rates and apply fertilizers to trees on school and home grounds.
    5. Visit local nurseryman to see fertilizer materials used and methods of applying them.
    6. Visit a local landscape that shows good tree and shrub fertilization and care.

Study questions and answers

A. Identifying trees and shrubs

1. What is the botanical classification of the plant kingdom in decreasing order of magnitude? (Major Taxa)
   Kingdom
   Division
   Class
   Order
   Family

2. List the minor taxa (classifications below family) in decreasing order of magnitude.
   Genus (plural genera)
   Species (abbreviated sp. or, for plural, spp.)
   Variety (Latin Varietas; abbreviated var.)
   Form (Latin Forma; abbreviated f.)
   Individual (Latin individuum)

3. Which taxa is used in the identification of trees and shrubs?
   Both the major and minor taxa are used, but the scientific name begins with the genus in which the first letter is capitalized, then the species which is not capitalized. Sometimes the variety and form are also given, but for general purposes of identification only the genus and species are used.

4. What is a tree?
   A tree is a woody perennial usually bearing a single main stem which commonly exceeds ten feet in height.

5. What is a shrub?
   A low, usually several stemmed, woody plant is called a shrub.

6. Distinguish between annual, biennial and perennial.
   These are classifications of plants based upon life spans. An annual usually completes its life cycle during a single growing season. A biennial completes the cycle during two growing seasons and a perennial grows for a number of years, sometimes hundreds of years. Woody plants are usually perennials.

7. What are deciduous plants?
   Plants which lose their leaves in the fall and stay bare all winter.

8. What are evergreens?
   Those plants which stay green all year by keeping their foliage during the winter.

9. What are the two classifications with regard to the position of leaves to the stem and to each other?
   Opposite - leaves are arranged directly opposite each other on the stem. If more than two leaves arise from the same position on the twig, they are said to be whorled. Alternate - the leaves are not opposite each other, but are staggered, one leaf on one side of the stem with the next leaf part way up the stem on the opposite side.

10. Explain the difference between pinnate and palmate leaves.
When the side veins of a leaf branch off from the midrib like a feather this arrangement is called a pinnate. But if the leaf has no central midrib and the veins arise from the leaf base like a hand, this leaf veination is called palmate.

11. What is the difference between simple and compound leaves?
A simple leaf only has one blade which is attached to the stem by a stalk called a petiole. A compound leaf has a number of blades which are attached to the stem by a single petiole. The arrangements of the leaf blades may be opposite along the petiole (pinnately compound) or all the leaf blades may arise from the end of the petiole (palmately compound).

12. What are the two main classifications of trees?
Broadleaved and needle-leaved.

13. What characteristics are used in identifying broad-leaved trees?
Opposite leaves, buds and branchings, presence of thorns, shape of leaves, presence and shape of flowers, presence and shape of fruit, twigs and buds, and bark.

14. All needle-leaved trees are evergreen except two. What are those?
Bald Cypress (Taxodium distichum) and Larch (Larix).

15. Name the seven genera of trees that have opposite leaves and buds.
Maple (Acer)
Ash (Fraxinus)
Paulownia (Paulownia)
Catalpa (Catalpa)
Buckeye (Aesculus)
Nannyberry (All Viburnum)
Flowering Dogwood (Cornus florida)

16. With respect to flowering, differentiate between dioecious and monoecious trees and perfect flowers.
Dioecious trees have male (staminate) flowers on one tree and female (pistillate) flowers on different trees and of course only those with female flowers will bear fruit and only then if a male flowering tree is close enough to fertilize the female flowers. Monoecious trees have both male and female flowers (separate flowers) on the same tree, whereas some trees have both male and female parts in the same flower which is called a perfect flower.

17. Name the trees that have thorns.
Hawthorn (Crataegus)
Osage Orange (Machura pomifera)
Common or Black Locust (Robinia Pseudoacacia)
Honey Locust (Gleditsia triacanthus)

18. Name the one genus of needle-leaved trees which do not bear cones.
Yew (Taxus)

19. Both the Pine and Larch have needles growing in clusters. How can these be distinguished?
The Pine has needles in clusters of two, three, or five and the Larch have many more needles which are short and feathery and are deciduous.

20. Of needle-leaved trees, whose needles grow singly, how may Spruce be distinguished from other genera?
Spruce (Picea) needles are foursided needles which are born on short projections on the twig which can be felt and seen where needles have fallen off.

21. Name the genera which have flat needles growing singly.
Fir (Abies)
Douglas Fir (Pseudotsuga taxifolia-not a true fir)
Yew (Taxus)
Hemlock (Tsuga canadensis)
Bald Cypress (Taxodium distichum)

22. Name the three genera which have scale-like or prickly needles.
Red Cedar (Juniperus virginiana) - both
White Cedar (Chamaecyparis thyoides) - flat, scale-like
Arborvitae (Thuja occidentialis) - flat, scale-like

23. What are the major classification of shrubs?
Broadleaved upright shrubs and needle-leaved shrubs (upright and prostrate-all evergreen).

24. What characteristics or parts of the plant are used to identify shrubs?
Thorns, leaves, flowers, fruit, twigs, and bark.

25. What is a ground cover?
These are small broad-leaved plants that normally do not grow over 12 inches in height and are usually quite dense.

B. Selecting and buying trees and shrubs

1. Why do we plant trees and shrubs around a home?
Shade
For borders
Wind break
Beauty
Attract birds
Add interest
Color in spring
Color in fall
Fence lines
Blend with building
Increase value of property
To screen objectionable views
To frame desirable views

2. What things should be considered in selecting trees for landscaping the home?
   - Size of buildings
   - Shape of buildings
   - Size of grounds
   - Location of drive or walks
   - Outdoor living area
   - Shade desired
   - Disease resistance
   - Insect problems
   - Rate of growth
   - Wind and ice damage
   - Freedom from trash
   - Leaf drop
   - Color desired
   - Special features wanted
   - Texture of bark and leaves
   - Shape of tree or shrub
   - Length of life
   - Climate and soil requirements
   - Size of tree or shrub when mature

3. What trees or shrubs will provide early spring decorative features?

Flowering shrubs

Silver bell, Caroline
Mock Orange
Lilac, Persian
Flowering plum
Quince, flowering Japanese
Forsythia
Sumac
Viburnum, Burkwood

Flowering trees

Tulip tree
Magnolia, saucer
Crabapple, flowering
Linden, little leaf
Dogwood Cornelian
Mountain Ash, European

4. What trees or shrubs may be used to provide bright fall decorative colors?

Shrubs	Fall color
Azalea, Ozalea mollis	Red--bronze
Cherry, Manchu	Reddish
Currant, Alpine	Yellow
Euonymus, dwarf wing	Rose--red
Fringe tree, White	Yellow
Hollygrape, Oregon	Bronze to purple
Honeysuckle	Blue--green

Trees	Fall color
Ash,	
Ash, Green	Yellow
Birch, European White	Yellow
Crabapple, flowering	Yellow to orange red
Dogwood, flowering	Red to violet
Cork tree	Bronze
Ginkgo	Yellow
Magnolia, saucer	Green to bronze
Sweetgum	Red--orange to yellow
Sassafras, common	Orange to red
Tupelo (black gum)	Orange, red, scarlet

5. What evergreen shrubs may be used to provide all year decorative value?

Shrubs	Flower or fruit effects
(narrow leaf)	
Yucca	Yellow to white flower, July
Yew, upright Japanese	Red fruit in fall and winter
Yew, spreading Japanese	Red fruit in fall and winter
Yew, Hatfield or Hicks	Red fruit in fall and winter
Junipers	Blue-green Foliage all year
(broad leaf)	
Convexleaf Japanese Holly	
Glossy Winter Creeper	
American Holly	
Gable Azaka	
Rhododendron, Catawba	

6. What coniferous trees may be used to provide full-year color and decorative value?

Red Pine
Eastern White Pine
White Fir
Nikko Fir
Oriental Spruce
Colorado Blue Spruce
Native White Spruce

7. What are some of the large trees that may be used in large open areas?

Sycamore Maple
Red Pine
Hackberry
White Oak
Scarlet Oak
Sweetgum
American Linden
Thornless Honeylocust
Tulip Tree

8. What are some of the small trees that could be used in small yards or lawn areas?

White Fringetree
Saucer Magnolia
Redbud
Smoketree
Panicled Goldenraintree
European White Birch
Kentucky Coffeetree
Amur Corktree
Flowering Crabapple
Flowering Dogwood
Amur Maple
White Mulberry
Serviceberry

9. What shrubs should be used for foundation plantings?

Spreading Japanese Yew
Spreading English Yew
Ward Yew
Woodward Arborvitae
Dwarf Mountain Pine
Sargent Chinese Juniper
Pfitzer Juniper
Dwarf Pfitzer Juniper
Andora Juniper
Waukegan Juniper

10. What trees are generally recommended for shade?

American Beech
Thornless Honeylocust
American Linden
Tulip Tree
Northern Red Oak
Japanese Pagodatree

11. What quality or grades of trees are available?
The American Standard for Nursery Stock has developed a standard which can be used as a guide indicating quality and sizes to buy.

12. In selecting trees for landscaping, what grade, size, and age stock is recommended for average home stock planting?
Size and grade are limited to a great extent by the amount one can spend for the trees and shrubs. Grades are standard to some extent so that one can expect a certain grade to be the same at any available source.

13. Why should you buy local plants, if possible?
Local plants are adapted to your climate and since shipping long distance may dry out plants, the local plants will transplant better.

14. In purchasing plants, how is height of deciduous shrubs reported?
Up to 24 inches the height is given in inches, but over 24 inches it is reported in feet.

15. How are evergreens described for purposes of sale?
Spreading type are described by the average spread not by the height. Upright evergreens are described similar to deciduous shrubs.

16. How are trees described for purposes of sale?
Height of tree or caliber of trunk are given as standards for trees. Caliber refers to the diameter of the trunk and is taken 6 inches above the ground for trees whose caliber does not exceed 4 inches the measurement is taken 12 inches above the ground.

C. Cultivating and mulching trees and shrubs

1. What is mulching?
Mulching is the process of covering the topsoil to reduce evaporation and cultivation.

2. Why is mulching used?
To improve soil tilth by adding humus, to prevent erosion, to control weeds, to conserve moisture and protect the plant from frost are some of the reasons for mulching.

3. What are some kinds of mulches you can use?
Various kinds of mulches are aluminum foil, buckwheat hull, corncobs, glass wool, grass clippings, hay, hops, leaves, manure, paper, peatmoss, pine needles, plastics, bark, sawdust, straw, tobacco stems, walnut shells and wood chips.

4. How should you select a mulch?
Some considerations in selecting mulch materials are availability, appearance, cost, effect on the soil, acidity of its reaction, fire hazard, rate of decomposition, weed-free characteristics, and disease-free characteristics.

5. What are some disadvantages of mulching?
Materials may be costly or difficult to obtain and some materials such as straw and other dry materials may become a fire hazard. Rodent problems may increase around mulched plants. You may get a nitrogen deficiency with corncobs or sawdust because these materials use nitrogen to decompose. Additional nitrogen should be added to decompose such organic materials.

6. What are some precautions to observe in mulching trees and shrubs?
Don't put mulch too close to the stem. Avoid "working in" the mulch without adding nitrogen and don't let the organic material substitute for fertilizer.

7. How does cultivation control weeds?
Weeds are controlled by hoeing one inch deep and letting the soil dry out. Dry surface soil acts similar to mulching to reduce weed germination.

D. Fertilizing trees and shrubs

1. Why should you fertilize trees and shrubs?
Nature affords plant nutrients by leaf, twig, and fruit decomposition along with animal matter decomposition. In city areas this is not true. The natural products of trees such as leaves, twigs and fruit are usually removed and the ground is covered with a thick lawn. Fertilization is necessary to balance the nutrient requirements.

2. What are the five cardinal principles of plant growth?
Light, temperature, air, moisture, and nutrition are the requirements for plant growth.

3. Why does the plant need a proper balance of each of these factors?
Due to the very complex relationship of these factors the plant must have the proper balance of each. For example, fertilized trees will withstand drought better than poorly fertilized trees.

4. What are five symptoms of ill health in trees?
Symptoms include sparse foliage, abnormally pale green leaves, the tips of twigs die back, drying or loosening of bark and abnormally slow growth.

5. Does the presence of lawns help or hinder the growth of trees and shrubs?
Lawns both help and hinder the growth of trees and shrubs. Lawns help by providing ground cover, a protective mulch that aids in water runoff and helps insulate the roots of trees and shrubs, but they hinder by competing with trees and shrubs for water, nutrients and air.

6. What four soil factors have a bearing on the growth of trees?
Fertility, drainage, aeration and moisture.

7. What is the profile of a tree's root system?
Some trees have descending roots and others have shallow root systems. However, most roots will be found in the upper 3 feet of soil and will extend outward a little beyond the spread of branches.

8. Where should you not place fertilizer for the tree?
   a. Close around the trunk (radius of 3 feet minimum)
   b. On top of the ground
   c. Too deep (more than 2 feet deep)

9. Where should you place fertilizer for the tree?
Fertilizer should be placed 18-24 inches deep in holes approximately two-thirds of the branch spread and one-third beyond. The holes should be 1 to 1½ inch in diameter.

10. How do you determine how much fertilizer to apply to a tree?
One method is to apply a certain amount per inch of trunk diameter. For trees 6 inches or under in diameter (DBH - diameter at breast height) should be fed at the rate of 2-3 pounds per diameter inch. Larger trees (over 6 inches DBH) should be fed 5 pounds per diameter inch.

11. What are other methods of feeding?
Spraying the leaves, spraying or painting thin-barked trunk or lower branches, and injections into the trunk.

12. When is the best time to fertilize trees?
In general, the best time is in the spring. This allows the tree to have adequate nutrients for active growth. Fertilization in mid-summer is less effective and in late summer or fall it should be avoided. Late fertilization stimulates new growth which may not have time to harden off before frost.

13. What are the major nutrients essential for trees and shrubs and what function does each play?
    a. Nitrogen - the element most responsible for green color and normal-living growth.
    b. Phosphorus - assists in the maturation of tissues, stimulates root growth and is important in the production of flowers, fruits and seeds.
    c. Potassium (potash) - helps tissues mature properly and heightens color of flowers.
    d. Magnesium and iron - essential in the formation and maintenance of chlorophyll.
    e. Calcium - improves the soil for the activities of beneficial microorganisms and other purposes.

14. How much fertilizer should you apply to shrubs?
There is no absolute formula to determine the amount of fertilizer to use, but a general rule of thumb is to apply one to three cups of a 10-6-4 formula per shrub.

15. Where should shrub fertilizer be placed?
Apply it from near the base to the outer spread of the branches and work it into the upper soil surface.

NURSERY MANAGEMENT

A Source Unit for Vocational Teachers

When and how to use this unit

This source unit includes the following problem areas:

A. Establishing and preparing a nursery site
B. Planting, transplanting, pruning and training nursery crops
C. Producing container stock
D. Maintaining soils in a nursery

This source unit should be viewed as a "starter" for the teacher but not as a complete teaching outline and plan. In the source unit on aboriculture problem areas on identifying, selecting, fertilizing, cultivating, and mulching trees and shrubs were included. This source unit on nursery management will focus primarily on problems involved in the planting and growing of crops in a nursery.

These problem areas in nursery management may be taught at almost any grade level from ninth grade on up depending on when the students are allowed to enroll in ornamental horticulture courses. Normally, vocational courses in ornamental horticulture will be scheduled for junior and senior students. Students need a background in soils, fertilizers, general science, and biology in order to get the most from this source unit.

The content and the field and laboratory exercises outlined in this source unit are best taught during the spring months. In the spring and early summer students can participate in field exercises and apply what they have learned in the classroom to a real-life situation.

Problem area outline

A. Establishing and preparing a nursery site
    1. Purposes and functions of nurseries
    2. Physical factors involved in locating a nursery
    3. Arrangement and layout
    4. Structures and separate units.
    5. Sources of planting stock
B. Planting, transplanting, pruning, and training nursery stock
    1. Choosing the time for planting
    2. Preparing native plants for transplanting
    3. Planting
    4. Caring for newly planted stock
    5. Becoming familiar with nursery terms
C. Producing container stock
    1. Origin and use of container production stock
    2. Container selection
    3. Media
    4. Irrigation
    5. Fertilization
    6. Winter care

D. Maintaining soils in a nursery
   1. Soil components and characteristics
   2. Cultivating plants
   3. Mulching
   4. Maintaining fertility levels
   5. Irrigating plants

Learning outcomes

The major behavioral changes which the teaching of this unit should promote are as follows:

A. To develop an understanding of how nurseries are arranged and operated
B. To develop the ability to perform basic nursery management practices
C. To acquire knowledges and skills related to container production

Suggestions for getting started

A. Have class describe their past experiences with planting nursery stock.
B. Take class on a field trip to a commercial nursery to see how plants are grown.
C. Bring container plants into the classroom and conduct a class discussion on how plants are grown in containers.
D. Bring specimens such as chlorotic leaves, die-back of plant tips, or abnormal twig growth and ask class to trace causes of these troubles.
E. Review basic principles of soil, water, and fertility relationships covered in previous science or agriculture courses.
F. Take a field trip to the school nursery and review the layout and arrangement of plants. Have students take a plant inventory.

Student references

A. Books
   1. Christopher, E. P., Introductory Horticulture, McGraw-Hill Book Company, Inc., New York, New York 10036, 1958.
   2. Hawley, Ralph C. and David M. Smith, The Practice of Silviculture, John Wiley and Sons, Inc., New York, New York 10016, 1954.
B. Pamphlets
   1. Kemmerer, H. R., Pruning Trees, Shrubs, Roses, University of Illinois, College of Agriculture, Extension Service in Agriculture and Home Economics, Circular 779, Urbana, Illinois, 1965.
   2. Tree Preservation Bulletin No. 1, Transplanting, U. S. Documents Office, Washington, D. C.

Teaching aids, equipment and materials

A. Teaching aids
   1. Samples of different soil types
   2. Plants showing different nutrient deficiency symptoms
   3. Samples of drainage tile

4. Charts with diagrams of:
    a. Digging (in and out)
    b. Balling and burlapping
    c. Root pruning
    d. Top pruning
    e. Staking and bracing
    f. The school nursery
    g. The local nursery

B. Equipment
1. Spades and long-handled shovels
2. Rakes and hoes
3. Soil test kit
4. Acidity test kit
5. Soil sampling tube
6. Soil sterilizer
7. Fertilizer injector
8. Pruning shears
9. Fertilizer spreader
10. Irrigation system or sprinkler
11. Wood burner (for making signs)
12. Roto-tiller
13. Carpentry tools
14. Level and target
15. Large and small pruning shears
16. Containers

C. Materials
1. Mulch materials
2. Sphagnum peat moss
3. Perlite
4. Ground corn cobs
5. Baled straw
6. Fertilizers
7. Plant materials
8. Tree wrapping paper
9. Marking tags
10. Stakes
11. Guy wire
12. Rubber hose
13. Burlap; 18" x 18", 24" x 24", 36" x 36", and 48" x 48"
14. Heavy cord
15. Balling nails
16. Wood preservative
17. Signs and markers

Laboratory exercises and special activities

A. Use the following laboratory exercises:
1. Balling and burlapping young trees
2. Planting a balled and burlapped tree
3. Bracing trees and limbs
4. Pruning shrubs
5. Pruning hedges

B. Take students on field trips to a commercial nursery to observe the following operations:
   1. Starting nursery plants
   2. Maintaining nursery plants
   3. Maintaining balled and burlapped stock
   4. Growing, fertilizing and irrigating in containers
   5. Preparing disinfectants and dipping flats and other containers
   6. Sprinkling systems
   7. Sterilizing media

C. Take students on a field trip to visit different tracts of land. Discuss the merits and de-merits of each for the establishment of a nursery.

D. Assign students responsibilities in the school nursery.

E. Provide the class the opportunity to perform the following activities:
   1. Order nursery stock for the establishment of small home nurseries.
   2. Construct a lath house.
   3. Prepare and plant a seed bed.
   4. Dig, ball and burlap trees. (Practice can be done without trees.)
   5. Plant bare-root material.
   6. Stake and wrap trees.
   7. Root prune and top prune.
   8. Construct shade and wind protection for newly planted trees.
   9. Set-up automatic irrigation equipment.
   10. Identify soil components, soil texture, structure, and percent organic matter.
   11. Heel in plants.
   12. Transplant materials into display areas.
   13. Dig beds for pit house and cold frames.
   14. Mix a fertilizer stock solution for injection. Calibrate the fertilizer injection system with the irrigation system to fertilize and irrigate plants.
   15. Prune plants in containers.
   16. Set-up overwinter protection.
   17. Plant materials from containers.
   18. Prepare a nursery soil sample and mail it to the state soil testing laboratory for analysis.
   19. Develop a demonstration plot with several types of mulches.
   20. Select and purchase containers, plant materials, fertilizers, media materials, and irrigation and fertilization equipment for school nursery use.
   21. Perform a few landscaping jobs each year to complete the cycle of container productions--raising to planting.
   22. Lay tile for drainage of individual beds and other major areas.
   23. Use the level to lay out contour lines.
   24. Operate and maintain a roto-tiller.
   25. Calibrate and operate a fertilizer spreader.
   26. Measure water application from a sprinkler system by use of an open container.

Study questions and answers

A. Establishing and preparing a nursery site

1. What is the definition of the word, "nursery?"
   A "nursery" is an area of land used for propagating plants until they are of sufficient size to be used for ornamentals or to be moved into production areas.

2. What areas in the United States have the largest number of nurseries?
   a. The Great Lakes region
   b. California and the Pacific Coast

3. What climatic factors promote good nursery growth?
   a. An abundance of moisture--five inches of rainfall per month during the growing season is desirable for the production of trees.
   b. Nearness to large bodies of water--to even out and absorb extreme weather conditions
   c. A growing season of approximately six months is desirable.

4. Under what conditions would it be advantageous for a landscaper to develop his own nursery?
   a. When output is of sufficient size to warrant the additional labor.
   b. When a labor source is available--such as farm labor.

5. What would be the advantage to the landscaper of having his own nursery?
   a. A greater variety of stock would be available to his business.
   b. Transportation damage would be reduced.
   c. Transportation costs would be reduced.
   d. A waiting period prior to planting would not be necessary.
   e. Plant materials would be available for home owners to view.
   f. Men could be employed over a longer period of time and used more efficiently.

6. What are the disadvantages of the landscaper operating his own nursery?
   a. High cost of labor
   b. Difficulty in finding skilled labor
   c. High demand on time of the landscaper

7. Why and how might a landowner fit a nursery into a production enterprise?
   a. To better utilize land
   b. To bring about efficiency of labor
   c. To utilize machinery to greatest efficiency
   d. To add income
   e. To work in conjunction with a nearby nurseryman or retailer

8. What are the advantages of a school nursery?
   a. Demand for plant materials is increasing.
   b. Better utilization of available land can be made.
   c. Labor could be provided by school students.
   d. The educational aspects of a nursery would be worthwhile.

9. What are the disadvantages of a school system having a nursery?
   a. Lack of understanding of responsibilities
   b. Rapid turnover of managerial personnel
   c. Requires more tedious work than educational advantage may warrant.

10. What are the physical factors to consider in selecting a site for a commercial nursery?
    a. The most important consideration is the soil.
       (1) A sandy loam soil would be first choice.
       (2) A sandy soil would be second choice, the idea being that the humus content could be improved upon rapidly.
       (3) Last choice of a site would be a clay soil. There would be a definite need for peat moss at the base of the plants as they were inserted and continuous addition of compost would be required.
    b. Slope must be considered.
       (1) There should be air drainage to a lower level.
       (2) The direction of the slope is better at a northern or a northeastern position.
       (3) The height should be elevated above the surrounding area.
       (4) Windbreaks may also be necessary.
    c. Native fertility is not important. Nursery stock has a very exhausting effect on the soil and fertilizers will need to be added constantly.

11. How important are roads and attractive entrances?
    a. An all-weather road is a necessity. A main road and smaller side roads may use a large amount of growing land, but it will ease the maintenance operations.
    b. The entrance is viewed by many people. It should be kept attractive with ornamental plants.
    c. An attractive and appropriate sign should mark the entrance.
    d. Individual blocks of plants should be marked with neat signs.
    e. Eventually the separate rows may be marked.

12. What are some important points to consider in arranging the layout for the different blocks of plants?
    a. Commercial nursery
       (1) Size of landscape service
          (a) Number of landscape planners
          (b) Number of landscape crews
          (c) Size of area to be served and its projected needs
          (d) Economic position of people in the area to be served

        (2) Availability of choice land
        (3) Cost of land
        (4) Cost of preparing land
        (5) Amount of money to invest
        (6) Cost of interest
        (7) Education and background of manager-owner
    b. School nursery
        (1) Size of school system and its potential for growth
        (2) Needs of the school system
        (3) Size of horticulture classes and the growth potential
    c. City nursery
        (1) Size of city and the projected need
        (2) Economic position of the citizens and local tax base
        (3) Age of the city and its needs
        (4) Type of industry

13. What records should a nurseryman keep?
    a. Maps of position and kinds of plants being grown in:
        (1) Planting beds
        (2) Lining-out beds
        (3) Hotbeds
        (4) Cold frames
        (5) Lath houses

14. Why should a nurseryman keep records on his business?
    a. To determine a fair price for plant materials
    b. To assist in identifying profitable and unprofitable plants
    c. To indicate where price changes are due
    d. To keep an account of plants on hand
    e. To aid in preparing maps
    f. To assist with future ordering by keeping records of past purchases.
    g. To assist in preparing income tax records
    h. To provide employment information for employees

15. Why does a nurseryman need the following structures?
    a. Greenhouse--Needed to propagate asexually the different types of cuttings.
    b. Cold frame--Needed to start seeds, to overwinter many of the less hardy plants, and to establish cuttings.
    c. Hotbed--Needed to start cuttings and seeds, to raise bedding plants, to overwinter bulbs, and to start bulbs.
    d. Lath house--Needed for hardening off plants, (especially broadleafed evergreens), and for overwintering many plants.
    e. Seed storage area--Needed for stratification of seeds.
    f. Seed beds--Needed to start conifer seedlings.
    g. Nursery beds-lining out areas--Needed to place young stock after arrival from hardening off area or from the commercial nursery.
    h. Markers--There should be a large entrance sign. Each section should be labeled. As the nursery grows, markers can be maintained for each plant variety. Listed on these markers should be common name, scientific name, and where propagated.

i. Compost area--Set aside from the rest of nursery. It could be in several divisions, divided by types of compost, length of time, and different fertility rates.
j. Heeling in beds--A shaded area to the north of a building or beneath the lath house. A small area, perhaps 10' x 10' reserved with loose mellow media would suffice.
k. Display area--This should be a dressed-up section of the nursery with walks, flowers and particular specimens accentuated. There could be several such sections throughout the nursery.
l. Service area--An enclosed section to keep tools and other materials.
m. Tool shed--Handy but not obvious. It should be kept neat and attractive at all times.
n. Work room--In the vicinity of the nursery, perhaps near the lath house. Neat and attractive inside and out. Well-planned with everything in its place.

16. At what age should plants be purchased?
In starting a nursery it is necessary to begin with some larger plants. Once the nursery is established then the manager can go to smaller stock, but he must keep ahead of the demands as plants take years to grow. He must keep in close contact with the landscapers and the architects.

17. How are planting stock compared from different nurseries?
Price and quality are both important. Contact different nursery owners for recommendations. Purchase plants from several sources and keep track of livability. Visit the sources if at all possible.

B. Planting, transplanting and pruning nursery crops
1. What is meant by planting and transplanting?
a. Planting consists of the establishment of nursery stock on the area to be restocked after it has successfully passed the critical stages of germination and early development. Seeding involves the sowing of seed in a place where the new crop is desired.
b. The process of transplanting is used when there is need for stock more sturdy than that which can be grown in seedbeds; the seedlings being dug-up and replanted in wide-spaced rows elsewhere in the nursery. Stock produced by this method are called transplants to distinguish them from seedlings grown in original seedbeds.

2. What is meant by pruning?
a. Pruning is the removal of dead or living plant parts to benefit those that remain.
b. Pruning is done to increase flower or fruit production, to improve appearance or to improve the form of the plant.

3. What is the accepted season for planting?
a. The best time for planting comes during the dormant season, preferably a short time before the growth of the stems and leaves is resumed.

b. Stock planted early in the spring can make contact with the soil more quickly than any other time.
c. Planting during the period of active growth in late spring and summer is not advised because of the rapid transpiration and respiration of the young tissues, slow growth of the roots in midsummer and the prevalence of hot, dry weather.

4. Can trees and shrubs be planted other than in the spring or the fall?
   a. With proper care, ball and burlap stock can be moved anytime except during the time of their greatest amount of new growth.
   b. The greatest amount of new growth occurs in the spring, April or May, depending on the area.

5. Why must bare root stock be heeled in if not planted immediately?
   a. This must be done so that moisture and nutrients will be available to the plant.
   b. If stored at just above freezing this is not necessary.

6. Why should plants be root-pruned prior to transplanting?
   a. This causes the roots to become denser and more fibrous.
   b. Not so many will be lost at transplanting time.

7. Why should plants be top pruned at transplanting time?
   a. Some roots will be lost at transplanting time.
   b. Top pruning will restore the top-root balance.

8. Why is it best to transplant in the spring or fall?
   Plants are dormant and much more likely to survive at these times.

9. What is the chief advantage of ball and burlap and container grown materials?
   a. The roots are left in a less disturbed state in the same soil.
   b. Transplanting is less of a shock to the plant.

10. How large a ball is needed with ball and burlap stock?
    An accepted rule of thumb is one foot of ball diameter for each inch of trunk diameter.

11. Is there any size limit on how large a tree may be moved?
    a. No, the only problem is if such a large ball of earth must be taken, it will be too heavy to move.
    b. Trees up to 24 inches in diameter and even larger can be moved by experts.

12. How is balling and burlapping done?
    Dig a trench around the tree and then cut under it. Do not apply any pressure on the ball. Place burlap around the ball, fasten it securely and handle by the ball, not the tree.

13. How deep should trees be planted?
    a. Slightly shallower than they were planted originally. They will settle slightly.
    b. The planting hole should be larger than the ball and filled with loose soil to insure proper aeration and drainage.

14. How long will transplants need special care?
    Normally it will be at least two years before the plant completely recovers from the shock of transplanting.

15. How much water will the plants need?
    Counting rainfall, they will need about one inch per week.

16. Why is wind damage severe in newly planted trees?
    Until the roots are reset, water uptake is slower and either winter or summer winds will cause more evaporation than the roots can replace.

17. Why is proper spacing of windbreaks so important?
    If planted too closely, the bottom branches of mature trees will shade out and die back. Eventually some of the trees will die, others will become unsightly.

18. What causes evergreens to turn brown in the fall and winter?
    Wind burn or desiccation. Plant processes slow or stop, including moisture uptake. Since the wind causes excess loss of moisture, it produces the browning effect.

19. Define the following:
    a. B and B -- Balled and burlapped.
    b. Dendrology -- The science or study of trees.
    c. Burning -- Leaves injured by exposure to strong sun or wind.
    d. Coniferous -- Trees and shrubs which bear cones.
    e. Deciduous -- Trees, shrubs, or vines that shed their leaves in winter.
    f. Defoliation -- Falling off of leaves.
    g. Desiccation -- Drying out.
    h. Dormant -- A plant in a resting or inactive state.
    i. Evergreens -- Plants which hold their foliage from season to season.
    j. Heeling in -- The placing of young plants temporarily in a trench in order to prevent the drying out of roots.
    k. Lining out -- Transplanting nursery stock from the propagation unit to the production unit.
    l. Pruning -- The removal of dead or living plant parts to benefit those that remain, to increase flower or fruit production, or to improve the form.
    m. Root pruning -- Process of trimming around a plant so as to sever the longer roots.
    n. Shrub -- A woody plant, usually of bushy habit, in varying sizes. It develops several stems instead of a single trunk, as does a tree.
    o. Transplants -- Any material dug and moved to a new location.
    p. Windbreak -- Any planting of trees or shrubs expressly to provide protection from the wind.

C. Producing container stock

1. What is container production?

   Production of a single plant of stock in a package containing media.

2. How does container production differ from field production?
   - a. Container production involves placing young plants in a sterile package of sterile media for growth.
   - b. Field production involves planting young plants in the nursery soil for growth.

3. Why use containers in the nursery?
   - a. Greater production per unit of area is obtained.
   - b. Plants are easier to handle.
   - c. Plant roots and media are lighter in weight.
   - d. Container production allows greater standardization of growing practices and "Cook-Book Growing." All plants receive identical care.
   - e. The planting season is longer.
   - f. No root pruning is necessary.
   - g. Cost per plant is lower.
   - h. Plants for sale require no digging.
   - i. Balling and burlapping are not necessary.
   - j. Less total labor per plant is required.

4. What types of nursery production containers are available?
   - a. No. 10 food cans (three and one-third quart)
   - b. Two gallon food cans
   - c. Peat pots
   - d. Plastic pots
   - e. Paper pots
   - f. Styrofoam pots
   - g. Veneer bands

5. What are the disadvantages of container production?
   - a. There is a higher initial cost per plant.
   - b. More winter injury is possible.
   - c. The life time of a plant in a container is limited.

6. What media are suitable for containers?
   - a. All media materials must be sterilized for container use.
   - b. A plant in a container does not have the capillary pull that a plant growing in soil does; therefore, media must contain additives to increase aeration and water-holding capacity.
   - c. A suitable media for container production is equal parts by volume of silt loam, shredded sphagnum moss, and perlite.
   - d. Another suitable media includes one part dune sand and one part shredded sphagnum peat by volume.

7. On what basis should containers be selected?
   - a. Availability
   - b. Economy
   - c. Color
   - d. Longevity
   - e. Handling ease
   - f. Storability

8. What things should be known about container irrigation?
   - a. Automatic watering is a necessity.
   - b. Hand watering is too time-and labor-consuming.
   - c. Three types of automatic watering systems are available. They include:
     - (1) Rain-King sprinkler that winds itself up on a tape as it moves down the row.
     - (2) Rainbird sprinkler system
     - (3) Spaghetti system--many small plastic hoses, each weighted and running into one container.
   - d. Tin cans should have openings on the sides at the bottom to allow drainage.

9. What things should be known about container fertilization?
   - a. Before potting, to one cubic yard of peat and dune sand (University of California) add:
     - (1) One pound of potassium nitrate
     - (2) One pound of treble phosphas (45 percent)
     - (3) Ten pounds of finely ground dolomite lime
     - (4) Five pounds of calcium carbonate
     - (5) Five pounds of finely group gypsum
   - b. A basic fertilizer mixture for a cubic yard of peat, perlite, and soil mix is:
     - (1) Six pounds of dolomitic limestone
     - (2) Three pounds of 10-10-10
     - (3) Three pounds of 0-20-0
   - c. Injected fertilization for University of California mix. To five gallons of water add:
     - (1) Four pounds of monoammounium phosphate
     - (2) Six pounds of technical grade muriate of potash
     - (3) Fifteen pounds of ammonia nitrate
   - d. Injected fertilization for perlite, peat, and soil mix:
     - (1) One pound 20-0-20 per gallon of water--stock solution.
     - (2) Inject stock solution at rate of 100 gallons of water per gallon of stock solution. (150 ppm N)

10. Where should containers be placed during production?
    - a. A paved or graveled surface is best.
    - b. Placing containers on soil is not recommended.

11. When should plants be placed in containers?
    Early enough so the plant root systems can become established before winter.

12. What overwintering protection do container plants need?
    - a. Container plants need more overwinter protection than field-grown plants.
    - b. Straw bales placed around the outside of the container group provide some protection. Ground corn cobs and straw spread among the containers provides insulation between the container.
    - c. Some nurserymen are successfully using poly-tents. Containers are covered with a structure of conduit under woven wire. A layer of polyethelene is then placed over this structure. The poly must be painted with aluminum paint and be made opaque to reduce condensation. Ventilation fans must be provided at each end of the structure. Heat must also be available during cold weather. The poly-tents have not been as successful in areas of great temperature variations. Winter losses in poly-tents have been reduced from 10-15 percent (without poly-tents) to two to three percent.

13. How long can a plant remain in a container?
    Not over two growing seasons. The roots become "pot bound" and will eventually die after being transplanted.

14. What plants can be grown in containers?
    - a. Almost all evergreens
    - b. Many deciduous plants

D. Maintaining soils in a nursery

1. What are the components of soil?
    - a. Mineral or inorganic particles
    - b. Dead and more or less decayed organic material of vegetable and animal origin
    - c. Water--called the "soil solution" because it contains traces of various salts which have been derived from the weathering of rocks and the decay of organic matter.
    - d. Air--which fills the spaces between soil particles that are not occupied by water.
    - e. Living insects, worms, protozoa, fungi, bacteria and other microorganisms.

2. What are the major types of soils?
    There are three broad groups of textural classes of soils.
    - a. Coarse-textured soils
        - (1) Include sands, loamy sands and sandy loams
        - (2) Are easily cultivated
        - (3) Warm up early in the spring, thus they can produce early crops.
        - (4) Are well-drained
        - (5) Can be improved by the addition of organic matter
    - b. Medium-textured soils
        - (1) Include loams which contain sand, silt, and clay in well-balanced proportions
        - (2) Include the most fertile soils

        - (3) Are easy to manage
        - (4) Break down into good tilth when dry
    - c. Fine-textured soils
        - (1) Include increased amounts of clay and silt
        - (2) Are more difficult to work
        - (3) Are slow to drain and are slow to warm up in the spring due to high water holding capacity
        - (4) Must be worked at just the right time, when neither too dry nor too wet
        - (5) May require artificial drainage

3. What is soil structure?
    - a. Structure refers to the arrangement of the individual soil particles.
    - b. Texture refers to the size of the individual soil particles.

4. How can good tilth be maintained?
    - a. Good tilth is achieved when the surface of the soil is loose and mellow and the underlying soil is cloddy and lumpy having larger pores through which fresh air can circulate and where water is held to meet the needs of the roots.
    - b. Good tilth can be maintained by working bulky organic manures that break down into humus into the soil.
    - c. Mixtures of manures, compost, peat moss and similar material can be applied to the soil and mixed thoroughly with it to provide better tilth.
    - d. Use of green manure crops can improve tilth.
    - e. Fertilizers applied to soil in poor tilth cannot be used most efficiently.

5. How can one determine if a soil is ready to work?
    Squeeze a handful of soil. When the pressure is released and the mass is compact, it is too wet. If it will crumble when jarred, it has proper moisture for working.

6. What are some soil management operations?
    - a. Plowing, rotary tilling or spading to bury surface portions of the soil and bring new parts to the surface where they will be affected by sun, wind, rain and freezing, to mix in organic matter and other aids to growth, to bury weeds, to improve drainage and to increase the amount of air in the soil.
    - b. Forking, harrowing or raking immediately before sowing or planting to develop a tilth most favorable to the crops that are to be planted.
    - c. Cultivating the surface with a hoe or cultivator to destroy weeds, to admit air and to conserve moisture.
    - d. Mulching to control weeds, to conserve moisture, to modify the soil temperature and in some cases to provide nutrients.

7. How can soil be cultivated to gain the most benefits with the minimum of harmful effects?
   a. Cultivate as shallow as possible to prevent root pruning.
   b. Cultivate only to control weeds.
   c. Eliminate excess trips and resulting compaction.
   d. Do not pulverize too finely and promote erosion by lowering infiltration rate.

8. How can the fertility level be maintained in a nursery plot?
   a. Nursery stock has a soil exhausting effect. Plantings should be made in blocks with soil building crops used on each block every few years.
   b. A complete fertilizer such as 10-6-4 with one-half the nitrogen in organic form should be applied at the rate of 1,000 pounds per acre per year.

9. When and by what method should commercial fertilizer be applied?
   a. Best results are probably secured by applying the fertilizer early in the spring before growth starts.
   b. Broadcasting of fertilizer, with care to prevent application too close to the plant stem, is probably the most practical.
   c. The fertilizer should be applied and worked into the soil so that deep root formation will be encouraged. A good watering after the fertilizer application will also move nutrients into the soil.

10. How can fertilizer needs of plants be satisfied?
    a. Plants which require special soil conditions may be kept in a separate block.
    b. Plants which require acid soil may be kept separately. Maple, Holly, Dogwood and Azalea require a pH of 4.5-6.0
    c. Plants subject to chlorosis, such as Pin Oak, may be treated individually with iron chelates.

11. How should mulches be used in the nursery to achieve better plant growth and reduce labor?
    a. A layer of organic mulch such as sawdust, peat, leaf mold, or compost will aid in weed control and moisture conservation.
    b. Mulches can be used to lower soil temperature.
    c. The addition of commercial nitrogen with a slowly decaying mulch such as sawdust will prevent the temporary depletion of soil nitrogen.

12. What are the indications of water deficiency in the soil? In the plant?
    a. If the soil is so dry as to fail to form a stable ball from a sample taken at one foot depth, then water is needed.
    b. Critical periods in plant growth occur when either a seedling or transplant is rooting and when there is rapid growth and expansion of the foliage area.
    c. If the plant shows any sign of wilting; if leaves are small; or if shoot growth is stunted, there is evidence of water need. (New transplants and seedlings must never be allowed to dry out.)

d. Soils which are cracked are drying rapidly and indicate the need for water.

13. How often and at what rate should water be applied?
    a. Water may be added when needed but frequent light sprinklings are to be avoided.
    b. Soak the soil to a depth of six inches or more when irrigating. A one-inch application of water applied at a slow uniform rate should be sufficient at one watering.

LANDSCAPING

A Source Unit for Vocational Teachers

When and how to use this unit

This source unit has been designed for use with high school students who have had no previous instruction in landscape design. The major purpose in teaching secondary school students about landscaping is to develop an interest and awareness of the problems involved in landscape design. Obviously, landscape architects cannot be trained at the high school level but vocational students enrolled in horticulture programs must be introduced to this important phase of work.

The three problem areas included in this source unit are as follows:

A. Landscape drawing
B. Developing a landscape plan
C. Selecting and building landscape structures

These three problem areas can be taught to high school students at any grade level; however, junior or senior students would probably benefit most from the unit. February and March would be ideal months to teach the three problem areas included in this source unit. Teachers may want to use the students' home grounds as a basis for drawing and landscape problems. This source unit can be easily correlated with students' home improvement projects.

Problem area outline

A. Landscape drawing
    1. Blueprint reading
    2. Selecting and using drawing equipment
    3. Types of drawings
    4. Making a working drawing
    5. Making a structural drawing
    6. Using landscape symbols
B. Developing a landscape plan
    1. Analyzing and drawing the site
    2. Locating private, public, and service areas
    3. Goose-egg planning
    4. Principles of landscape design
    5. Developing plans for different lot shapes
    6. Evaluating a landscape plan
C. Selecting and building landscape structures
    1. Fences and walls
    2. Patios and walks
    3. Ponds and pools

Learning outcomes

The major learning outcomes which should be achieved by the teaching of this source unit are as follows:

A. To develop the ability to draw and read a landscape plan.
B. To gain an appreciation of the importance and beauty of proper landscape designs.

C. To promote an understanding of some of the principles of landscape design.
D. To develop the ability to choose and use landscape structures.
E. To develop the ability to evaluate landscape designs.

Suggestions for getting started

A. Take class on a tour to observe poor and excellent examples of landscape design.
B. Show class the landscape drawing for the school grounds.
C. Secure copies of a landscape drawing for a local residence. Have class study the drawing and discuss it.
D. Take a field trip to measure one of the student's home grounds and to collect the necessary data for making a drawing.
E. Visit a garden center to observe various construction materials.
F. Have the class make models or cutouts of plants and structures for use on a flannel board.
G. Invite a landscape architect to speak to the class about landscape planning for residential areas.
H. Involve class in the planning of a landscape design for a church or other community building.

Student references

A. Nelson, William R., Jr. Landscaping Your Home, Circular 858, University of Illinois, College of Agriculture, Urbana, Illinois.

Teaching aids and equipment

A. Drafting table
B. T-square
C. Triangles
D. French curves
E. Compass
F. Templates
G. Lettering guide
H. Pencils and pencil sharpener
I. Scale and ruler
J. Eraser and erasing shield
K. Drafting tape
L. Paper
M. Tape measure
N. Surveyor's level
O. Slides of landscape designs developed by the instructor
P. Wall charts of plant materials
    a. George J. Ball Company, West Chicago, Illinois (free)
    b. Willis Nursery, Ottawa, Kansas (free)
Q. Stakes
R. Hatchet
S. Concrete finishing tools
T. Electric wire (underground waterproof)
U. Electric wiring tools
V. Recirculating pumps
W. Various landscape rock and brick
X. Peat and perlite used in preparing the planting media
Y. Shovels, rakes, hammers
Z. Catalogs of plant materials

Laboratory exercises and special activities

A. Laboratory work
   1. Perform the laboratory exercise "Developing a Landscape Plan."
   2. Prepare a plan for a selected site.
   3. Read blueprints and plans.
   4. Using drawing equipment, prepare a simple scale drawing.
   5. Prepare a scale plan of a previous project.
   6. Perform standard plumbing skills with both plastic and iron pipe.
   7. Wire night-scaping lights and reciprocating pumps.
   8. Practice trowling and forming concrete with and without forms.
   9. Practice mixing concrete with various materials and with sand and gravel in various proportions.
   10. Lay flagstone with and without mortar.
   11. Fit and join railroad ties to use in terrace construction.
   12. Make a model of a typical terrace structure (in the shop) using small stone and synthetic plant materials.
   13. Make a collection of landscaping rocks and stones.
   14. Make a small model of a landscape pool practicing shaping, working concrete, and securing the proper fall.
   15. Construct a wood retaining wall for pouring concrete.

B. Special activities
   1. Take a field trip to nursery where a landscape designer works.
   2. Take a field trip to a large manufacuring plant and grounds to study landscape planning with the grounds superintendent and landscape drafting with the landscape architect.
   3. Build a classroom model to illustrate the advantages and disadvantages when planning for the following lots:
      a. Long, narrow
      b. Pie shaped
      c. Rectangular
      d. Corner
   4. Prepare sketches illustrating both desirable and undesirable landscape planning.
   5. Take a field trip to study the landscape planning of corner, rectangular, pie, and long, narrow shaped lots.
   6. Take a field trip to see various uses of terraces, ponds, and pools.
   7. Take a field trip to observe the building of these structures.
   8. Have a landscape architect talk to the class.
   9. Construct a terrace, pond, or pool for the school grounds.
   10. Construct a terrace, pond, or pool for a student's home grounds.

Study questions and answers

A. Landscape drawing

1. With respect to the definition of landscaping, what role does the landscape architect perform?
   He creates a plan to make the best use of the available space in the most attractive way.

2. How does a landscape blueprint differ from a building blueprint?
   The landscape blueprint is usually drawn to a scale of 1/16, 1/8 or 1/4 inch to one foot whereas the building blueprint scale is larger. The symbols are also much different since the landscape blueprint shows locations of fixed objects as well as plants.

3. List the drafting materials and equipment desirable for landscape drafting.
   This equipment includes a drawing table or board, T-square, triangles, french curves, compass, templates, lettering guide, pencils and pencil sharpener, scales, rulers, erasers, and eraser shield, paper and drafting tape.

4. Name the two most important pieces of drafting equipment.
   A drafting table and pencils.

5. What is the function of the T-square and plastic triangles?
   The function of the T-square is to provide an aid for drawing lines. The use of triangles in conjunction with the T-square aids in drawing vertical and angular horizontal lines.

6. Describe the use of plastic templates.
   These are used to draw almost any type of geometric design or symbol. There is a special template which features landscape symbols.

7. How is a scale used?
   A scale is used to determine measurements but not to draw lines.

8. What type of paper should the drawing be put on?
   Commercial landscape architects use transparent paper so the drawing can be blueprinted but if the drawing is for personal use, it may be placed on graph paper for ease in drawing things to scale.

9. How do perspective and orthographic drawings differ?
   The perspective drawing shows everything exactly as it would appear in a photograph. The orthographic drawing is drawn to scale but it only shows one view at a time such as a side view, top view or end view.

10. Which classification of drawings is used in landscaping and why?
    While occasionally a perspective drawing may be used, the orthographic is used mostly because it is so much easier and less expensive to make.

11. In landscape drafting there are names for the top, front and side views of orthographic drawing. What are these?
The top view is called the plan and the front and side views are called elevations.

12. What is a structural drawing?
This is a detailed drawing of particular structures such as patios, steps or fountains in which the scale is larger than the plan and is attached to the working drawing. These are orthographic drawings.

13. What is a working drawing and what does it include?
A working drawing is the completed drawing with all pertinent information attached which the landscape contractor uses to landscape the area. It should include the plan, elevations where necessary, structural drawings, enlargement of difficult areas and all dimensions. All systems such as water systems and drainage or wiring systems should have separate drawings attached.

14. What do landscape symbols denote and how are they used?
Symbols show the location and size of trees, shrubs, hedges, buildings and permanent structures. They are used on the landscape plan to show the location of the various elements in the landscape design.

B. Developing a landscape plan

1. What is the purpose of a landscape plan?
It is to create a plan which, when carried out, will result in the best use of space available in the most attractive way. It should make the most of the site's natural advantages as well.

2. What are three primary considerations involved in successful landscape planning?
First, you should consider your lot or site as a cube of space in which the ground is its floor, the property lines are its walls, and the ceiling is the canopy created by structures, tree plantings or the sky. Next, you should keep in mind the relationship between primary living areas in the house and comparable areas outside. Finally, you should consider the design from outside the house.

3. Name the three major areas of the landscaped site.
The public area which extends from the front of the house to the road, the private area or outdoor living area which is usually located in the back yard, and the service area which includes space for garbage cans, work areas, clothes lines and similar items.

4. Name a few principles to keep in mind in designing the public area.
The front door is the most important element in this area. Corner plantings should provide a smooth transition from the vertical lines of the house to the horizontal lines of the ground.

If a driveway is present, then front walks should be incorporated into the drive so as to avoid dividing the lawn in half. Eye-catchers such as garden embellishment and circular flower gardens should not be put in the public areas.

5. What are some principles to use in designing the private area?
The private area design is very flexible. It should meet the family's needs and desires. If possible it should be easy to get to, favorably located with regard to wind and sun, and located so it may be viewed from inside the house.

6. How do you analyze the site?
The first thing to do is study the character of the land, its slopes, valleys and hills. Your basic plan should reflect the natural surroundings. Your site does not end with boundaries so you should determine the natural views you wish to preserve and incorporate this into your plan. You should consider the location of walks, drives, existing trees and shrubs, drainage problems, soils and climate.

7. What is "goose-egg" planning and how is it used?
This is a process of roughly approximating the location of the public, living and service areas. It is used to help determine the space required for each area and what changes need to be made in ground forms.

8. List some general principles of landscape design.
   a. Locate the patio or terrace early in the designing process and plan the rest of the garden to take advantage of the patio location.
   b. A raised edge provides interest in a flat yard.
   c. Garden steps do not have to be in a straight flight but they should have a wide tread and a low riser.
   d. To frame an off-property view, make your garden a foreground to open up and frame the view.
   e. Symmetrical balance in garden is rigid and formal. Subtle effects are achieved by asymmetrical balance.
   f. A broad, simple curve is usually more desirable than a series of small curves.
   g. The minimum size desirable for a patio is 15 feet by 20 feet.
   h. Flower beds should be at least 2 feet to a maximum of 5 feet deep.
   i. In general, everything in the landscape should be wider than it is tall.
   j. In determining height in general, different things should be of different height while similar things should be of similar height.
   k. Since it is impossible to plan ahead for everything, don't be afraid to revise plans as you go along.
   l. Straight lines should lead to something.

9. How does the lot shape affect your landscape plan?
If your lot is of an unusual shape such as a pie shape then it will determine your basic plan since the boundary lines are the walls of your site. Long, narrow lots have the advantage of being partitioned into areas easily but it may be hard to get a good transition between areas.

10. In evaluating your plan, what are some things to consider?
    a. Does the basic design reflect the natural surroundings?
    b. Does it meet your family's needs?
    c. Have the natural and climatic factors been considered in selecting plants to go in the design?
    d. Is it within your financial means to implement this plan?
    e. Finally, after all has been considered, have you made the "best" use of the space available in the most attractive way?

C. Selecting and building landscape structures.

1. What do we mean by the term landscape structures?
These include such things as surfacing materials other than plants. Steps, retaining walls, fences, baffles or walls used for privacy, usable space or pattern are examples of structures.

2. In general, what purposes do these structures serve?
Landscape structures serve the same purpose on small farmstead areas or city lots as plantings do on large areas. Fences, baffles and screens can be used for privacy or as windbreaks. Walls can hold steep slopes and banks, and steps can be used for easy access between levels.

3. What are three primary considerations to observe in deciding which structures to use?
The considerations are the natural ground forms on the property, the property analysis and the family inventory.

4. What does the term "enclosure" mean?
It is used to describe the many types of barriers and screens that can be used in a home landscape.

5. Should you use the same interval for both enclosure and paving in the patio?
As a general rule you should not. A brick patio should usually have a wooden fence.

6. What is the general rule to follow in selecting material to be used in constructing fences, patios and other structures?
All material used in the landscape should harmonize with the house materials in texture, scale and color.

7. What is the main purpose of fences?
Fences are usually constructed for privacy but they serve many additional purposes. The amount of privacy you will get depends upon the size and type of fence.

8. How do walls differ from fences?
Walls may be used for purposes similar to fences but they are usually constructed stronger. They may be used to create raised planting beds, seat walls, or soil and retaining structures.

9. List some of the common types of fences.
Picket, split grape stake, high board fence, plywood, corrugated asbestos panel, corrugated aluminum, corrugated plastic, louver, basket weave, lattice and wooden rail fence.

10. What are some of the common surfacing materials used in the private area?
Loose surfacing materials include such things as tanbark, gravel, mixed rock, and crushed limestone and granite. Hard surfaces include concrete, asphalt paving or blacktop, brick and flagstone. Semipermanent materials are such things as wood blocks and wood rounds.

11. What are some of the paving patterns which can be used for brick and stone?
Bricks may be placed in herringbone (flat or an edge), basket weave (flat or an edge) and running (flat or across). Stones may be placed in a random rectangular pattern, irregular pattern, or irregular fitted pattern.

12. What is the purpose of landings in a series of steps?
These landings break up the monotony of a long flight of steps and also they provide an excellent place to change direction of the steps.

13. What is the maximum height of a step riser and the minimum width of a step tread?
A six-inch riser is the maximum and a 12-inch tread is the minimum for outdoor steps. Other proportions are: a five-inch riser to a 15-inch tread; a four-inch riser to an 18-inch tread or; a three-inch riser to a 24-inch tread.

14. What are the functions of a garden pond or pool?
A pond provides a cooling effect as well as performing a decorative function. A swimming pool has a cooling effect through moisture evaporation as well as serving entertainment, recreation and exercise needs.

15. What are some factors to consider in designing a pool?
The primary use to be made of the pool and the site restrictions, as well as economics will affect the size and shape of the pool.

16. How thick should the concrete be in a pool?
The sides should be five inches thick and the bottom should be eight inches thick mixed in proportions of one part cement, two parts sand, and three parts crushed stone.

17. What is the purpose of putting cinders under the bottom of the pool floor?
A layer of cinders should be spread and tamped over the bottom of the excavation to allow for drainage under the pool and reduce the chances of heaving due to frost. The depth of cinders will vary according to the type of soil from a few inches for sandy soil to twelve inches for heavy clay soils.

FLOWERS AND FLORAL ARRANGEMENTS

A Source Unit for Vocational Teachers

When and how to use this unit

This source unit includes four problem areas which may be taught at the secondary or postsecondary level. The problem areas outlined in this unit are as follows:

A. Storing and caring for cut flowers
B. Arranging bouquets and floral pieces
C. Judging flowers
D. Forcing lilies for Easter

The content included in this unit does not include all the knowledge and learning experiences which vocational students majoring in floral arrangement or floral shop management need to have. Teachers should view this unit as an introduction to the subject of flowers and floral arrangements and should supplement it according to the vocational objectives of their students.

The first three problem areas in this unit should be taught in the order listed and preferably in September or April. The problem area on forcing lilies must be started in December in order to have lilies ready for the Easter season.

Learning outcomes

The learning outcomes which the teaching of this unit may help achieve are as follows:

A. To develop an understanding of the principles involved in storing and caring for cut flowers
B. To develop the ability to make simple flower arrangements
C. To gain an appreciation of top quality flower specimens
D. To develop the ability to select varieties of lilies and lily bulbs
E. To develop the ability to follow a planting and growing schedule for Easter lilies

Suggestions for getting started

A. Bring a vase of freshly cut flowers to class and have students tell how these flowers should be cared for and handled. The purpose of this activity is to find out "where the students are" with respect to the problem area.
B. Show the film "Williamsburg Flower Arrangements" available from most school film companies.
C. Secure copies of leaflets from local florists or Florists' Transworld Delivery to show students types of arrangements and cost of each.
D. Take the class on a field trip to a top-notch florist to see how flowers are handled and stored.
E. Take class to see a flower show and to observe the judging of flowers.

F. Show class colored slides of different flower arrangements.
G. Have class plan a lily-growing project for the Easter season.

Problem area outline

A. Storing and caring for cut flowers
    1. Cutting flowers
    2. Storing cut flowers
    3. Caring for cut flowers
B. Arranging bouquets and floral pieces
    1. Types of arrangements
    2. Fundamentals of design
    3. Tools and equipment used in floral arranging
    4. Care of flowers before and after arranging
C. Judging flowers
    1. Preparing flowers for show
    2. Scoring flower collections
D. Forcing lilies for Easter
    1. Selecting varieties
    2. Selecting and buying bulbs
    3. Preparing potting soils for lilies
    4. Planting the bulbs
    5. Caring for growing lilies
    6. A guide for timing Croft lilies

Student references

A. Books
    1. Kasperski, Victoria R., How to Make Cut Flowers Last, M. Barrows and Co., 425 Park Avenue South, New York, 1956.
    2. Fox, Raymond D., A Teacher's Guide to Flower Arrangement, The Kenneth Post Foundation, Ithaca, New York, 1960.
    3. The Ball Red Book, written by the staff of Geo. J. Ball, Inc., West Chicago, Illinois, 11th Edition, 1965.

Teaching aids, equipment and materials

A. 6" clay pots
B. Peat
C. Sharp sand
D. Greenhouse soil
E. Soil sterilizer
F. Coarse gravel
G. Calcium nitrate
H. Ammonium sulphate
I. Parathion, malathion, lindane
J. Terraclor
K. Captan
L. Colored slides of properly prepared specimens for shows
M. Contrasting slides of poorly prepared specimen flower arrangements
N. All of the hardware on display which could be used in preparing a specimen or group of specimens for show

Laboratory exercises and special activities

A. Laboratory exercises
    1. To show the effect of light upon cut flowers

2. To show the effect of temperature upon flowers in storage
3. To show the effect of flowers as to the time of day that they are cut
4. To show the rate of water uptake of cut flowers with cold and hot water
5. To show the effect of preservatives upon the life of cut flowers
6. To show the effect of ethylene gas upon storage life
7. Arrange flowers in various massed line, and combination arrangements.
8. Arrange a specific flower specimen for proper showing.
9. Pot lily bulbs, (mix soil media, add lime, provide sufficient drainage, space depth level.)
10. Space lily plants on a greenhouse bench.
11. Water and fertilize lily plants.

B. Special activities
   1. Conduct a flower show for members in the horticulture class.
   2. Take a field trip to an area or district flower show.
   3. Visit a greenhouse where lilies are forced.
   4. Visit a wholesale market where lilies are sold.

Questions and answers

A. Storing and caring for cut flowers

1. In general, when is the best time to cut flowers?
The preferred time to cut flowers is in the late afternoon after the sun has gone down. Flowers cut at this time have a reservoir of plant food that has been built up during the day. The second best time is in the very early morning.

2. At what stage should flowers be gathered?
They should be gathered in the advance-bud or nearly mature stage. If they are cut sooner, they may not continue to open and if they are cut later their life is shortened.

3. How should flowers be cut?
The stems should be cut slantwise with a sharp knife - not with a scissors. For hollow stems, the cut should be made through the node not through the hollow part. This has many advantages some of which include better water conduction and longer flower life.

4. How do cut flowers take up water?
The cut flowers can only take up water through the cut end of the stem. This is why stems are cut slantwise, to expose more cells for water absorption.

5. Why are cut flowers "conditioned" in a darkened room?
Flowers are placed in a darkened room to cause the stometa or minute pores which are located on the underside of the leaf to close thus keeping the rate of water evaporation down.

6. How deep should the water be for conditioning flowers?
Flowers should be conditioned in deep water to prevent evaporation through stems petals and foliage, but in storage the only water which is taken in goes through the stem so shallow water is sufficient.

7. At what temperature should flowers be stored?
If it is dry air storage, the temperature should be 31° F. In refrigerators which have relatively high humidity the temperature should not be more than 50° F.

8. What are some factors that prolong the life of cut flowers?
Some of these factors include placing cut flowers in water as soon as they are cut, keeping containers and water clean and free from bacteria build up, and the adding of certain chemicals to the water in which the flowers are placed.

9. What are some factors that hasten fading of cut flowers?
Once pollination has occured in flowers, they will fade and shed their petals quickly. Other factors are the presence of ethylene gas which may come from the decaying process of petals and leaves of cut material, high heat, and low humidity.

10. What are some factors to keep in mind when storing flowers using the 31° F. "dry" storage method?
Some of these factors include the following: store only top quality flowers. Cut when the bloom is tighter than freshly used flowers. Make the containers air-tight. Place flowers in storage right after they have been cut. Keep the temperature as close to 31° F. as possible. Every degree above 31° F. means poorer quality.

B. Arranging bouquets and floral pieces

1. What should be the source of designs for floral arrangements?
All ideas for floral designs, either abstract or natural should come from nature. A close observation of design relationships, patterns of growth, and details in relation to the environment can provide a continuing source of ideas for design.

2. What are the five elements of design?
These are form, line, space (silhouette), texture, and color.

3. How are these elements combined in a floral arrangement?
A predominant form is selected and the other elements are chosen in such a way as to integrate them into a unified pattern.

4. What is the significance of each of the elements of design?
Form is the inner structure as well as the visible shape of an object. In design three basic geometric forms are used; namely, the cube, the sphere, and the pyramid. Line establishes the structure of a design and sets the quality of motion. The solids of plant materials, their outline and the spaces around them constitute space. Texture, as the composition of the surface materials, influences design since we touch things imaginatively when we look at them. Color is the most compelling element of design and the most important to control.

5. What are the six principles of design?
Balance, proportion, scale, rhythm, contrast, and dominance.

6. What are the three types of design?
Three types of designs dominant in America today are line, massed design and massed-line design.

7. What characterizes a line design?
Strong lines as opposed to big masses dominate a line design. The lines establish the movement and rhythm of the design.

8. What characterizes a massed design?
The elements which characterize a massed design are depth and fullness, with emphasis on groupings of flowers and pleasing drifts of color.

9. What makes a massed-line arrangement unique?
A massed line design employs both massed and line principles with an emphasis on line for the basic structure. The mass helps to create the three-dimensional impression which is characteristic.

10. What are some mechanical aides used in floral arrangements?
In addition to containers and such ornamental pieces as driftwood and candles, you can use such aids as needle-point holders, floral clay, sticky tape, wet newspaper, cup pinholders, wire and Oasis holders.

11. What should be done to condition flowers before arranging them?
Flowers should be cut either in early morning or late afternoon and soaked in warm water for at least three hours or preferably overnight before arranging them.

12. What care should be given flowers after they have been arranged?
Floral arrangements should be kept out of direct sunlight and away from excessive heat. The water may be changed periodically in same arrangements.

C. Judging flowers

1. What are the three purposes which a well-planned and executed amateur flower show should accomplish?
The purposes are to stimulate an interest in horticulture and especially floriculture, to develop an aesthetic sense, and to educate the public.

2. Why is it a wise precaution to announce the names of the judges only after they have completed their work?
Some exhibitors may attempt to play up a judge's known tastes and interests therefore reducing the fairness of the show.

3. In using mechanical aids, why should these be carefully concealed?
Holders, lead strips, wire, scotch tape, and other things when not concealed good may cause points to be deducted under both design and distinction.

4. Why is an exhibit judged "as is" by the judge?
In all cases it must be judged as it is when the judge sees it and not as it will look four hours later or as it looked three hours earlier when it was placed on exhibit.

5. Why should a person wishing to enter one or more entries in a flower show secure the schedule of the show and read all the rules carefully?
It could very well make the difference of a blue ribbon winner or being disqualified by the classification committee for not following the rules for a particular class.

6. In judging any design in a show, what is the basis used in scoring?
An exhibit is judged against perfection in all aspects and not against other exhibits in the show.

7. What are the two divisions of any Standard Flower Show?
Divisions are horticulture and arrangement. Each division must have a minimum of five classes.

D. Forcing lilies for Easter pots

1. What is the scientific and common name of Easter lilies?
The scientific name is Lilium longiflorum and the common name is white trumpet or Easter Lily.

2. What are the most popular strains of Easter lily bulbs produced in the United States?
Ace, Croft, Nellie Whites and Georgias are some of the popular strains with Ace being the most important.

3. Why is Ace the most popular variety?
Ace is the most popular because it is least susceptible to tip leaf burn and gives more buds under normal growing conditions.

4. Where do most of the lily bulbs come from?
The largest concentration of production of lily bulbs in the United States is in the Pacific Northwest near the California Oregon state line.

5. Give the bulb sizes and grades of lilies.
The bulb size is determined by the largest circumference of the bulb and measured in inches and the grades are determined from size. These are:

Grade	Size of circumference
6½/7	6½" to 7"
7/8	7" to 8"
8/9	8" to 9"
9/10	9" to 10"
10/up	10" and over

6. How long are lilies precooled and why?
Lilies are precooled for a minimum of five weeks and maybe longer depending upon the Easter date. The precooling has the effect of bringing the bulbs into flower sooner and therefore the longer the bulbs are cooled the sooner they will flower.

7. What size pots are lilies potted in for pot plant sale?
They are usually potted in 5½ or 6 inch standard pots.

8. Are lilies stem-rooted? Explain.
Yes, lilies are stem-rooted. They produce roots from both the bottom of the half and from the portion of the stem that is under the soil. For this reason they should be potted a minimum of 2 inches below the surface of the soil.

9. Why is it vitally important to plant lily bulbs at a uniform depth?
This will help attain an even emergence of negative growth which is most desirable.

10. What would a typical soil mix for lilies contain?
This might consist of 1/3 coarse peat, 1/3 sharp sand and 1/3 good structured greenhouse soil.

11. What pH should a lily soil have?
The desirable pH of a lily soil should be from slightly acid to neutral - pH 6.5 to 7.0.

12. How many days before Easter should lilies be potted?
This will depend upon many variables but a rule of thumb is to pot the bulbs 120 days before Easter.

13. At what day and night temperature should lilies be grown?
Beginning about 100 days before Easter the temperature should be 70°-75° F. during the day and 60° at night.

14. When should a grower start the feeding program on lilies?
Feeding should start when the root system is well developed and top growth has started.

15. What fertilizer should be used? When?
A fertilizer which is low in phosphate, or which is straight nitrogen, or a combination of the two fertilizers should be used in a watering solution, approximately every two weeks.

16. Why should the more advanced plants be put in the cooler areas?
This will slow down growth and therefore cause them to bloom later. The timing of the blooms are controlled in this way.

17. What insect pest is of chief concern on lilies?
Aphids.

18. What is used to control these insects?
Parathion, Malathion, Lindane or Systox (demeton) are used to control aphids.

19. What two diseases are most prevalent in lilies?
Leaf scorch and root rot.

20. How are these diseases controlled?
Leaf scorch is best controlled by proper fertilizing and by keeping the soil pH between 6.5 and 7.0. Root rot can be prevented rather than controlled. Some preventive measures include the use of sterilized soil, good greenhouse sanitary practices, loose well-drained soil and avoidance of overwatering.

21. How can the forcing of lilies be speeded up?
   a. Use additional light at night.
   b. Manipulate temperature the last 100 days.
   c. Increase temperature and humidity.
   d. Water with lukewarm water.

A GUIDE FOR TIMING CROFT LILIES

Timing of lilies is always a problem. No two growing situations are exactly the same. Light and temperature vary from place to place and environments within individual greenhouses differ too. Therefore, the best guide for you to follow is one which you have developed for your situation over a period of years. The following is a table which should be used only as a rough guide for a beginner in his lily forcing program.

No. of days to Easter	Approximate stage of development
115	Potted up and placed in cool greenhouse or shed.
101	Developing roots; 55° F.
94	Developing roots; grown on from this date at 60°.
87	Pushing up through soil.
78	Stems two to three inches in height.
72	Stems four to six inches in height.
66	Stems six to eight inches in height.
59	Stems ten inches in height.
53	Stems 15 inches in height.
47	Can feel buds in leaf cluster.
40	Buds becoming visible.
35	Buds one-half inch long.
30	Buds one and one-half inches long.
24	Buds two to three inches long, some bending down.
17	Buds three to five inches long.
12	Buds fully developed.
8	Buds whitish and puffy; plants cooled.
4	Some buds opening, plants cooled.
0	Sold on Easter.

The above schedule allows 115 days for forcing Croft lilies. Many growers work on the basis of 120 days. However, if Easter is late, the growing period is shortened to compensate for the warmer, brighter weather in March and April. Some authorities recommend extending the period to as much as 130 days and keeping the potted bulbs at 50° for the first three to four weeks. They claim a better developed root system, with thriftier subsequent growth and higher bud count. Remember, too, that some of the slower growing varieties, such as Ace, may require one and one-half to two weeks longer than Croft.

Brief Cultural Notes

If precooled lily bulbs reach you too early, they should be stored at 33°-35° F. until potted up. Use five and one-half or six inch pots, and plant each bulb with its nose roughly two inches below the soil surface. Some growers prefer to start their lilies cool (50°-55° which tends to reduce legginess), then grown on at 60° night temperature.

Start your fertilization program when the stems are several inches above the noses of the bulbs, and continue it until the plants are ready for sale. A porous soil, well drained and aerated, with pH near neutral; avoidance of phosphate fertilizers; and moderate to high levels of nitrogen, potassium, and calcium all help to minimize the disorder known as "leaf scorch."

Keep on your toes with regard to timing. Every grower knows the hazards of bringing in lilies too early or too late. In general, it is wiser to hurry the crop along a bit in the earlier stages with a little extra heat (then hardening them at cool temperatures near Easter) than to try to speed up development in the final week or two with 70° temperatures. If the plants are advancing too rapidly, drop the night temperature three to five degrees. Lighting for four to five hours a night starting in February speeds up a "slow" crop, but may cause weaker stems and too much elongation and is seldom recommended.

Excessive "stretch" in lilies is usually caused by crowding, low light intensity, and overwatering--although excessively high temperatures, varietal strain differences, and physiological condition of the bulbs also enter in. Give your lilies ample space, with the lower leaves adjacent plants barely touching. And avoid placing lilies in dark houses or on benches that are shaded for even part of the day. They need lots of light, so be sure there is no shade remaining on the glass.

Should your Crofts mature too early, they can be stored up to two weeks in a cooler (40°-50° F.). See that they are well watered before storing. It is usually best to move them to the cooler when some buds are in the white, puffy stage.

APPENDIX C

FIFTY LABORATORY EXERCISES FOR VOCATIONAL ORNAMENTAL HORTICULTURE STUDENTS

FLOWER AND HOUSE PLANT LABORATORY EXERCISE

Mixing Potting Soil

Purpose

To outline a procedure for mixing a batch of potting soil.

Materials

1. Loam, sand and peat moss or other organic material.
2. Fertilizer or soil amendments.
3. Wheelbarrow and shovel. (Large batches)
4. Trowel and containers. (Small batches)

Procedures

1. A standard potting mix contains 2 parts loam, 1 part sand, and 1 part peat moss or other equivalent organic matter. Clayey soils should not be used in a container mix.
2. Decide on the amount of mix needed.
3. Soak the required amount of peat moss thoroughly with water.
4. Throw alternate shovelsful or trowelsful of peat moss, loam, and sand into the mixing pile so as to get the correct proportions.
5. Rethrow the layered pile into a new pile for further mixing.
6. Flatten this pile and spread any needed fertilizer or soil amendment evenly over the top.
7. Rethrow the mix.
8. Use in a damp condition so mix retains its shape when squeezed.

Questions

1. What is the composition of a standard potting mixture? ________
   ____

2. What are the main characteristics of a good standard potting mixture? ____
   ____

3. What conditions will cause the ratio of the standard potting mixture to be altered? ______________________________
   ____
   ____
   ____

4. What soil should not be used in a soil mix? ______________

FLOWER AND HOUSE PLANT LABORATORY EXERCISE

Germinating Seeds

Purpose

To demonstrate a rather simple and unique method for germinating flower seeds.

Materials

1. Seed flats (See Diagram 1) or milk cartons
2. Soil and vermiculite
3. Shredded peat moss
4. Sand or perlite
5. Sphagnum moss
6. Row marker (See Diagram 2)
7. Protective fungicide such as thiram, or ferbam
8. Small seeds such as petunias, snapdragons or begonias

Procedures

1. Seeds may be planted in a wooden flat, half-section of a milk carton, or other flat containers. The flat or container should have cracks or holes in the bottom to provide for adequate drainage.
2. Use a mixture of 2 parts loam, 2 parts sand or perlite, and 1 part shredded peat moss. The soil mix, the containers, and tools should be sterilized with steam or chemical. Soil may be held at 180° F. for 30 minutes to sterilize it. If this is not possible, use commercial formalin (37-40 percent formaldehyde in water solution) to sterilize the soil mix and utensils.
3. Cover cracks or holes in the containers with moist sphagnum moss to hold the soil. Fill flat or container up to 3/4 inches from the top with screened soil mix.
4. Level and firm the soil in the container by using a row marker or a 1" x 3" board. Sprinkle the soil and allow excess water to drain away.
5. Spread 1/4 inch of vermiculite over the surface of the soil mix, level but do not pack, and sprinkle lightly with water. For larger seeds 1/2 inch of vermiculite should be added.

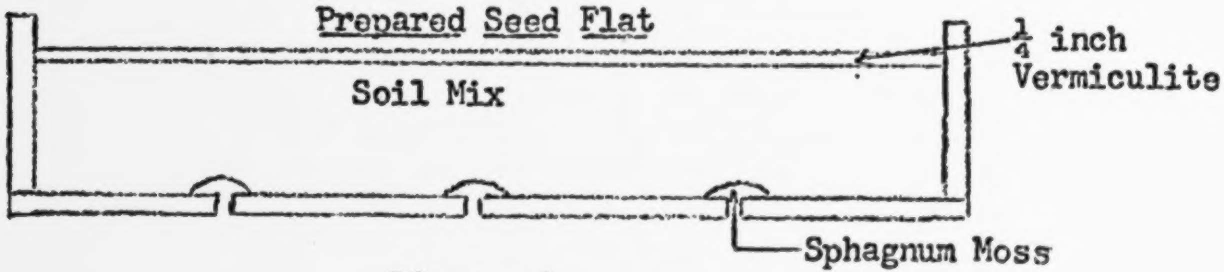


Diagram 1

6. Mark rows in the vermiculite by using a row marker cut to the proper dimensions to make rows 1/8 inch deep. Rows should be laid out 2 inches apart.

Row Marker

Diagram 2

7. Treat seed with thiram, ferbam, or some other fungicide by adding about a pinch of powder equal to the size of a match head to the seed packet. Shake vigorously. If the seed has already been treated it should be so indicated on the packet.
8. Sow seed thinly and uniformly by using a seed vibrator or by tapping the packet lightly to shake seed into the rows. A layer of fine peat moss may be scattered in the rows before seeds are planted.
9. Cover the seed with a thin layer of vermiculite and moisten with a fine spray of water. Very small seeds should be planted shallow. The covering of vermiculite should be no thicker than three times the diameter of the seed.
10. Cover flat with a clear plastic to retain moisture and place in the greenhouse or a semi-shaded, draft-free location with a temperature of 65°-75° F. Gradually lift the plastic covering as seeds begin to germinate.
11. Check moisture twice a day and water only when necessary. Sub-irrigation or a fine mist spray may be used to keep the vermiculite moist.
12. When germination is complete move flat to a well-ventilated location that has full sunlight. Maintain temperature at 55° F. at night and 65° F. during the day.
13. Watch seedling development for damping-off and plant food deficiencies. Thiram or ferbam which were used to treat the seed may be used to make a drench for the treatment of damping-off.
14. Transplant seedlings as soon as they can be conveniently handled by the leaves. See the laboratory exercise on transplanting for suggested procedures to follow.

Questions

1. What is germination? ______________________________

____

2. What factors influence germination? ______________________

____

3. How deep should seeds be covered? _______________________

____

4. How and why are seeds treated? _________________________

____

5. Why is vermiculite a good medium for germination? ____________
____

6. Why were the cracks in the seed flat covered with sphagnum moss?
____
____

7. What is the purpose of sterilizing the soil and container in this exercise? ________________________________
____
____

8. In general, what should be the relationship between size of seed and depth of planting? ________________________
____
____

FLOWER AND HOUSE PLANT LABORATORY EXERCISE

Transplanting Seedlings to Pots

Purpose

To outline an efficient method of transplanting seedlings from flats to pots or other containers.

Materials

1. Rooted seedlings (annuals, biennials, or perennials)
2. Four-inch pots
3. Peat moss
4. Soil mixture (one part loam, one part sand, and one part peat moss)
5. Labels

Procedures

Preparation for Transplanting

1. Place rooted cuttings or plants on the left.
2. Place the empty pots in front of the soil pile.
3. Provide a space for the potted plants on the right.

Transplanting Seedlings to Pots

1. To fill shove the pot into the soil pile with the right hand while picking up the plant with the left. (Caution: Handle small plants by the leaf, not by the stem.)
2. Make a hole with finger or dibble.
3. Place the plant in the hole.
4. With the thumbs and forefingers of both hands compress the soil on each side of the plant in one motion.
5. Leave at least half the width of the lip of the pot free of soil.
6. While potting keep the roots of seedlings from drying out by covering with a light plastic sheet.
7. After transplanting, the potted plants should be moved to the greenhouse bench as soon as possible and watered throughly.

Questions

1. Why are the transplanting materials arranged as suggested in the laboratory exercise? ______________________________
____

2. What is a dibble? ______________________________
____

3. Why do you compress the soil around the plants roots? ________
____
____

4. Why don't you fill the pot completely with soil? ____________
____

5. Why should plants be watered throughly after transplanting? ___
____

FLOWER AND HOUSE PLANT LABORATORY EXERCISE

Removing Plants from Pots for Repotting or Transplanting

Purpose

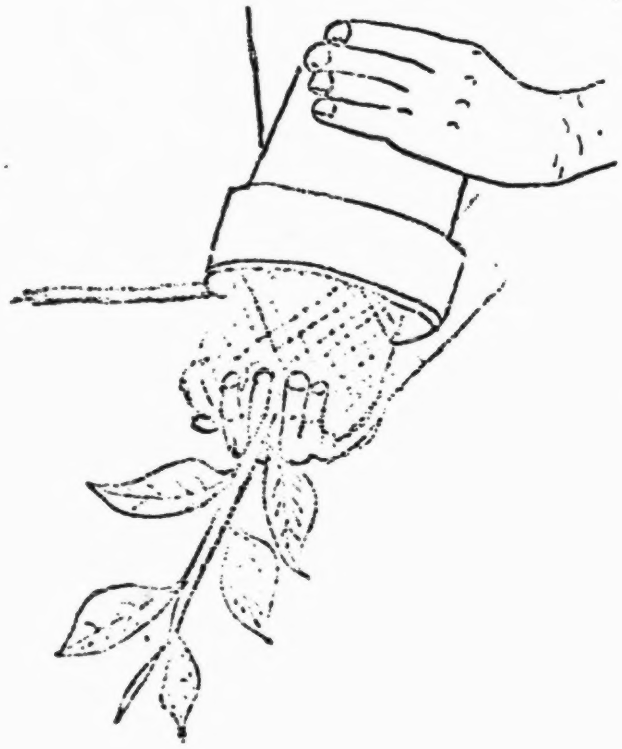
To demonstrate the proper method of removing plants from pots for transplanting or repotting.

Materials

1. Several potted plants which need repotting or transplanting.
2. Table edge, garden stake or trowel handle used to tap the pot against.

Procedures

1. Place one hand on the soil surface to support the ball of soil. Spread your fingers around the plant stem.
2. Place the pot against the table edge and with the garden stake or trowel handle tap the top edge of the pot firmly but gently against the hard surface.
3. Allow the plant with the ball of soil to slip down out of the pot and remove the pot with the other hand.
4. Place the removed plant ball upright in your free hand and transplant the plant ball to the prepared hole in open ground or to a larger container. Do not allow roots to be exposed to the air for an extended period.



FLOWER AND HOUSE PLANT LABORATORY EXERCISE

Preparing a Terrarium Showcase for Small Plants

Purpose

To outline a procedure for preparing and maintaining a terrarium for miniature plants.

Materials

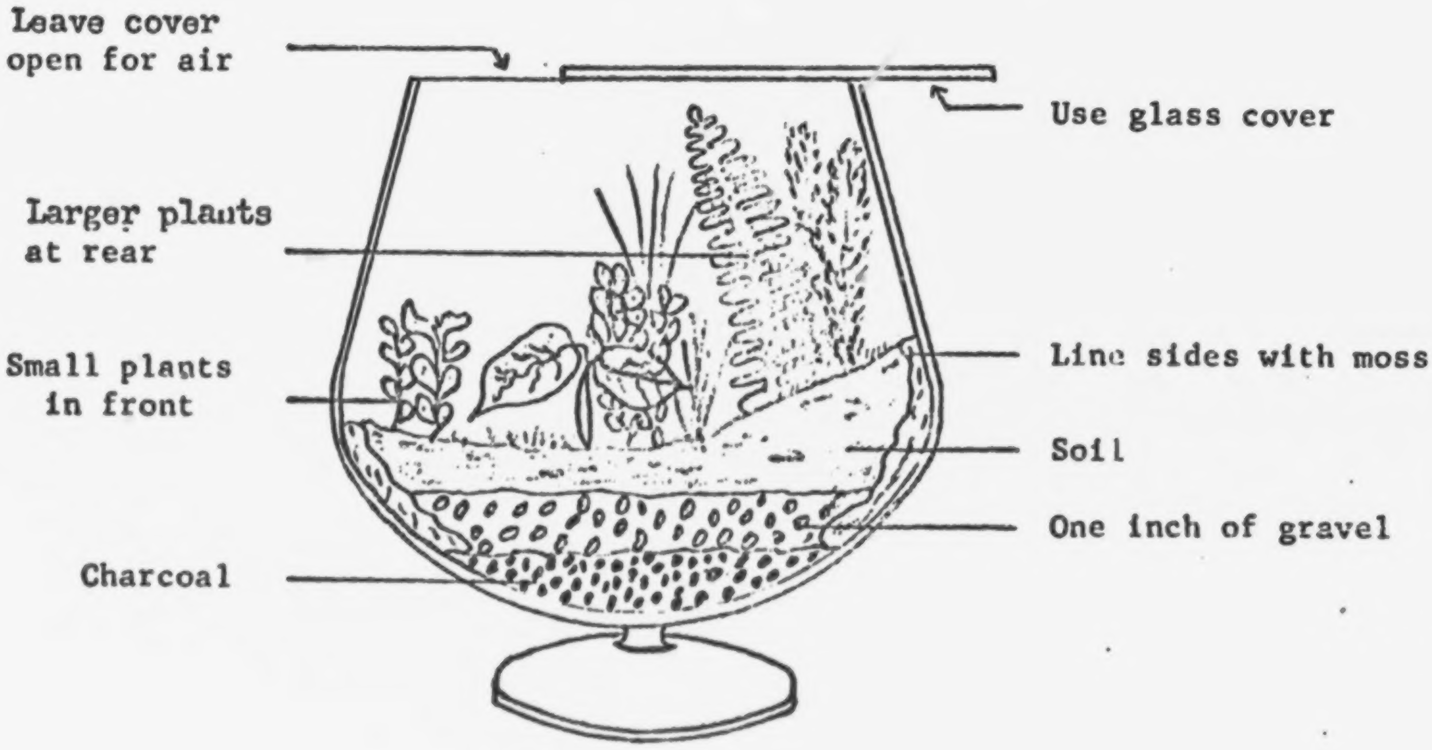
1. Terrarium container (a large glass bowl or jar)
2. Glass cover for the terrarium
3. Charcoal
4. Moss
5. Soil
6. Gravel
7. Number of plants suitable for terrarium growth. Examples include: Baby's Tears, Begonias (everblooming), Fittonia, Ivy (miniature types), Maranta, Palms (small), Pteris (table ferns), Peperomia, Saintpaulia (African Violet); wood plants: evergreen seedlings, dogtooth violet, Dutchman's breeches; hepatica; varieties of mosses; mushrooms.

Procedures

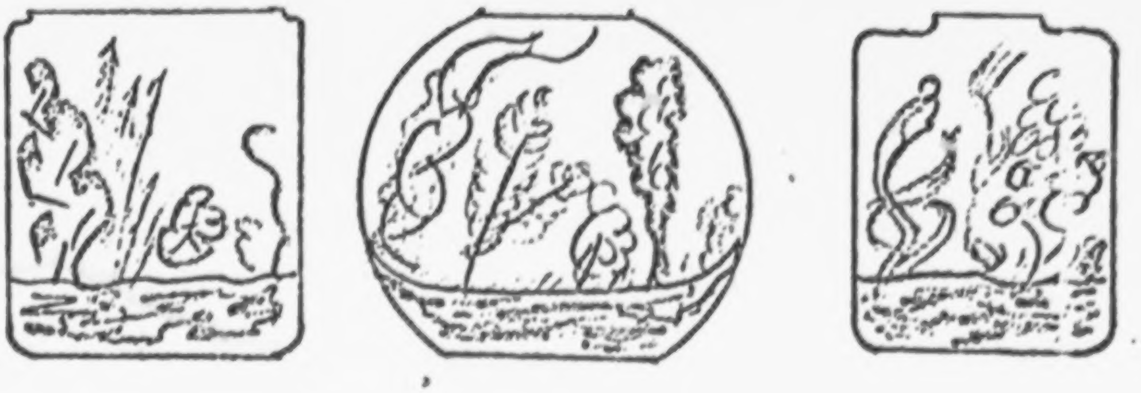
1. Select an attractive container for the terrarium. A large jar or bowl is satisfactory. Wash the container thoroughly and polish it so it will sparkle.
2. Determine where the terrarium will be displayed. If it is to be viewed from one side, place larger plants in the background and smaller plants toward the front.
3. Line the container with moss, green side out, to the height the container will be filled with soil. This will give the bottom and sides of the container an attractive appearance.
4. Place one-half to one inch of charcoal in the bottom of the container. On top of the charcoal, place one inch of gravel.
5. On top of the gravel place one or two inches of soil. A good medium is a soil mixture of two parts loam, two parts coarse sand and one part leaf mold. This mixture is not so rich that the plants will rapidly outgrow their rather limited space.
6. Arrange the soil into small hills and valleys. Place each plant in the terrarium so it will present a desired contrast of shape and color with surrounding plants. Place variegated foliage next to solid and colorful plants next to green plants. An effective arrangement is to have a plant of major interest near the front and center of the terrarium.
7. As the plants grow too large and distort the appearance of the small environment, replace them with cuttings or plants of the appropriate size. Keeping the small scale proportion and effect is much of the charm of the terrarium.

8. Place the terrarium in good light, but not in direct sunlight, as this would overheat and kill the plants.
9. Place a glass cover partially over the terrarium to control humidity and watering. If moisture condenses on the cover, remove it for a time.
10. Maintain the terrarium in an attractive place.

TERRARIUMS


Leave cover open for air
Use glass cover
Larger plants at rear
Small plants in front
Line sides with moss
Soil
One inch of gravel
Charcoal

Other Shapes of Terrariums



FLOWER AND HOUSE PLANT LABORATORY EXERCISE

Making Moss Sticks for Climbing Vines

Purpose

To outline a procedure for making and setting up moss sticks for climbing vines.

Materials

1. Strip of 30- or 36-inch wide ¼-inch hardware cloth. A ten-inch length is needed for each cylinder to be made.
2. Small diameter flexible wire.
3. Tin snips or shears.
4. Pliers.
5. One pot or planter approximately nine-inches in diameter at the top.
6. One three-inch to four-inch diameter pot to set at the top of the moss stick.
7. Gravel.
8. Standard potting soil mixture.
9. Mixture of one-half peat moss and one-half vermiculite or perlite sufficient to fill the cylinder.
10. Three to five young potted vines. Some examples are philadendron, gold-splashed devil's ivy and canary islands.
11. Two small wooden sticks for braces.
12. Hairpins.
13. Paper funnel.
14. Hand scoop.
15. Tamper or broom handle.

Procedures

1. Cut off a ten-inch strip of one-fourth-inch hardware cloth from a 30-or 36-inch wide strip. The width of the strip depends on how tall you want the planting to be when finished.
2. Roll the one-fourth-inch cloth into a cylinder of approximately three inches in diameter and 30 or 36 inches in height. Overlap the edges about three-fourths of an inch and fasten at six-inch intervals with small diameter wire. Cut off the excess wire with a pliers.
3. Place two inches of gravel in the bottom of the nine-inch diameter planter for drainage. Put two small wooden sticks at right angles through the mesh at the bottom of the cylinder to help brace it. Place the cylinder sticks down in the planter. Plumb the cylinder and fill the planter to about four inches from the top with a standard potting soil mixture.
4. Make a mixture of one-half peat moss and one-half vermiculite or perlite. Soak the peat moss over night in water beforehand. Make a cardboard or paper funnel to aid in filling the cylinder with the mixture. While filling, tamp the mixture at intervals with a stick or broom handle to pack the mixture firmly.

5. Unpot three to five young vines and space them around the cylinder. Fill around the roots with soil to within one inch of the rim to allow room for watering.
6. Train the vines by twisting them to grow in a spiral around the cylinder. Fasten the vines to the moss stick with hairpins inserted at a sharp angle.
7. Place a small pot at the top of the cylinder and fill it with water. The water will seep into the moss stick and provide a moist medium for support roots to grow into. Water should be added daily.
8. When watering, fill the planter to the brim. Repeat until it drains out the bottom, then empty the saucer. Do not rewater until the surface soil gets dry.

TURF MANAGEMENT LABORATORY EXERCISE

Establishing a New Lawn with Plugs

Purpose

To outline the procedure for establishing a new lawn with plugs.

Materials

1. Plow, roto-tiller or spade
2. Rake
3. Balanced fertilizer
4. Roller
5. Area that has access to water
6. Lawn plugs of Merion Bluegrass, Creeping Bent, Meyer Zoysia or Delta Bluegrass. One hundred plugs will plant approximately 50 to 100 square feet of lawn area. This is based on two-inch plugs planted 6 to 12 inches apart. Plugs planted closer together will make a lawn much more quickly.

Procedures

1. Prepare the area for plugging by working, raking, smoothing, and leveling the soil.
2. Apply a balanced fertilizer over the soil at a rate of application needed as shown by a soil test. Mix the fertilizer into the soil with a rake.
3. If the weather is exceptionally hot and the soil dry, moisten the soil slightly before placing the plugs.
4. Plant the plugs 6 to 12 inches apart. If the weather is extremely hot, water the plugs as you plant them. To plant, drop or place them, roots down, every 6 to 12 inches. Step on the plug to push it into the soil so it is in good contact with the soil. The closer the plugs are planted, the sooner the lawn will become established.
5. Go over the area immediately after planting with a roller to make sure all plugs are in contact with the soil.
6. After planting and rolling the plugs, give them a thorough watering. This is important. If there is a doubt as to whether or not you have watered enough, water them again.
7. Observe the newly planted plugs for several days. When they start to dry out give them another "soaking." The plugs should not be allowed to dry out completely.
8. After the plugs have started growing, water only once every week or ten days. One good watering once a week in dry weather is much better for your lawn than daily watering.
9. Mow the lawn as soon as there is anything to mow. Mow often and regularly. In the spring and fall twice a week is not too often. Mowing height for various grasses:

Kentucky Bluegrass	2 inches
Merion Bluegrass	1 1/2-2 inches
Delta Bluegrass	2 inches
Creeping Bent	1/2-3/4 inches
Meyer Zoysia	3/4 inches

10. Maintain a balanced fertilizer program. A simple effective program would require a 10-8-4 fertilizer applied every six weeks at a rate of 20 pounds per 1,000 square feet, starting April 1.
11. The newly plugged lawn will become established much faster if it is kept free of weeds. Use of chemical weed killers will save a considerable amount of hard work. In hand weeding, take care that new grass shoots or runners are not mistaken for weeds. Frequent and regular mowing will discourage weeds.
12. Properly planted and maintained plugs will spread into a solid luxurious carpet of thick, beautiful lawn grass within a year when planted into a newly-prepared lawn area.
13. Some types of old lawns may be converted to other grasses by plugging the new grass into the old established grass, however, this is a slow procedure. First, plug out the old grass to a depth of about one inch by approximately two inches in diameter using a trowel, pointed spade or plugger. Place the plugs in areas that have been dug out and press the plugs down so that they are in contact with the soil. Mow frequently and at the recommended height. Following is an outline of the types of grasses which may be converted.

    a. Kentucky Bluegrass to Creeping Bent--Good.
    b. Kentucky Bluegrass to Merion Bluegrass--Good.
    c. Kentucky Bluegrass to Meyer Zoysia--Good but slow.
    d. Creeping Bent to Meyer Zoysia--Slow.
    e. Merion Bluegrass to Meyer Zoysia--Very slow.
    f. Creeping Bent, Merion Bluegrass or Meyer Zoysia to Kentucky Bluegrass--Not practical.

TURF MANAGEMENT LABORATORY EXERCISE

Turf Species and Variety Plots

Purpose

To show the differences in appearance, adaption and use of different species and varieties of grasses.

Materials

1. An area in which to seed different species and varieties of grasses. An area on the school grounds or school farm which is easily accessible for student and public observation is desirable. An area of 20' x 60' is large enough for twelve 10' x 10' plots.
2. Different species and varieties of grass seeds. (Suggestions will be offered in section on "Procedures.")
3. Hopper spreader or shaker box to plant the seed. The hopper spreader is most accurate. Hand seeding can be used if a hopper spreader or shaker box is not available. A cyclone type spreader is not too desirable for seeding small plots.
4. Other materials and equipment needed in seeding and maintaining a lawn such as rakes, rollers, straw, burlap, and mower.

Procedures

1. Select a 20' x 60' area which is easily accessible for student and public observation.
2. Prepare the area for seeding by working, fertilizing, raking, smoothing and leveling the seedbed.
3. Mark off the area into twelve 10' x 10' plots. The plots should be marked by attractive signs. Included should be species, variety, and date of planting.
4. Seed each plot to show differences in appearance and use of different species and varieties of grass.

Species	Kentucky Bluegrass	Kentucky Bluegrass	Bentgrass	Ryegrass	Zoysia	Fescue
Variety	Common	Delta	Creeping	Annual		
Species	Kentucky Bluegrass	Kentucky Bluegrass	Bentgrass	Ryegrass	Bermuda	Buffalo
Variety	Merion	Windsor	Penncross	Perennial		

TURF MANAGEMENT LABORATORY EXERCISE

Turf Management Demonstration Plot

Purposes

1. To show the effects of different heights of mowing on turf
2. To show the effects of removing and not removing cuttings from turf
3. To show results of crabgrass control
4. To show results of broadleaf weed control
5. To show the effect of mowing with a sharp blade and dull blades
6. To show results of frequency of mowing
7. To demonstrate the application of fertilizer needed as shown by soil tests on the above plots versus no fertilizer application

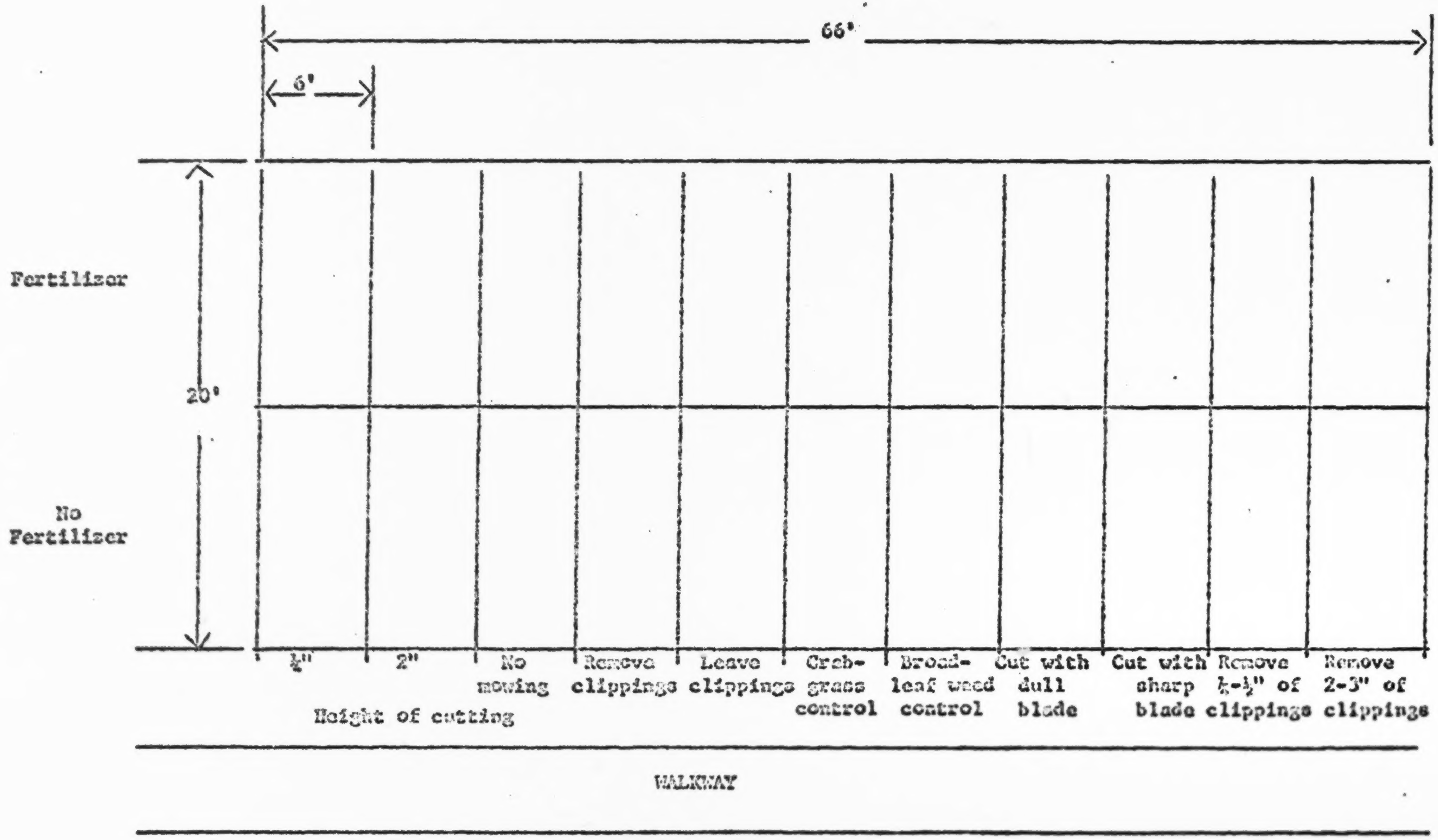
Materials

1. Space on a school lawn or any established lawn
2. Mowing machine with an adjustable height of blade and a clipping catcher
3. Sharp and dull blades for the lawn mower
4. Chemical for broadleaf weed control (2-4D)
5. Chemical for crabgrass control (Pre-emergent, Dacthal, postemergent, CSMA or AMA)
6. Fertilizer for needed application as shown by soil tests
7. Markers or signs to identify practices on the plots

Procedures

1. Select a portion of a lawn on the school grounds or other appropriate place.
2. Mark off an area for demonstrations.
   a. An area of 20' by 66' is suggested. This can be divided into twenty-two 6' by 10' plots as shown in the diagram in Step 3.
   b. Select the plot near walkways where the demonstrations can be observed.
   c. Make signs to identify practices on the plots.
3. See plot layout diagram on the following page.
4. Place signs at the front of the appropriate plots.
5. Take soil tests to determine the correct amount of fertilizer to apply.
6. Perform the suggested practices and maintain them on the plots throughout the summer. Modifications can be made to fit local situations.

Step 3--Lay out the plots as suggested in the diagram below.


66'
6'
20'
Fertilizer
No Fertilizer
¼"
2"
No mowing
Remove clippings
Leave clippings
Crab-grass control
Broad-leaf weed control
Cut with dull blade
Cut with sharp blade
Remove ¼-½" of clippings
Remove 2-3" of clippings
Height of cutting
WALKWAY

Observations

Make the following observations periodically.

1. Height of cutting demonstration
   a. Which plot was the most acceptable in appearance?

   b. Did any of the plots seem to be adversely affected by different heights of cutting?

      If so, which one(s)?

   c. List reasons why most grasses should be mowed to a height of 1½-2".
      1.

      2.

      3.

      4.

   d. List the reasons why close cutting should be avoided.
      1.

      2.

      3.

   e. List the reasons why no cutting is undesirable.
      1.

      2.

      3.

2. Clipping demonstrations
   a. Is there any observable difference between the plots where clippings were caught and removed and where clippings were left by the mower?

      If there is a difference, describe.

   b. List the advantages of catching and removing the clippings from the lawn.
      1.

      2.

      3.

c. List the advantages of not removing the clippings from the lawn.
   1.

   2.

   3.

3. Crabgrass control demonstrations
   a. Was the crabgrass control effective?

   b. Was there any observable difference of crabgrass control between the fertilized and unfertilized plots?

4. Broadleaf weed control
   a. Was the broadleaf weed control effective?

   b. Was there any observable difference of broadleaf weed control between the fertilized and unfertilized plots?

5. Sharpness of blade
   a. Was there any appreciable difference in the use of sharp versus dull blades on the appearance of the plots?

   b. List reasons why a dull blade is undesirable.
      1.

      2.

      3.

6. Frequency of cutting
   a. Does frequent cutting (removal of ¼-½" clippings) harm the lawn?

   b. List reasons why it is undesirable to let a lawn grow to 4-5" before cutting back to 2".
      1.

      2.

      3.

5. Below is listed species and varieties of grasses classified as northern and southern species which could be used in the turf demonstration plots.

Northern Species
(Tennessee and Northward)

- A. Bentgrass
  - 1. Arlington
  - 2. Colonial
  - 3. Creeping
  - 4. Penncross
- B. Bluegrass, Kentucky
  - 1. Arboretum
  - 2. Common
  - 3. Delta
  - 4. Geary
  - 5. Merion
  - 6. Newport
  - 7. Park
  - 8. Troy
  - 9. Windsor
- C. Bluegrass, Rough
- D. Fescue, Red
  - 1. Chewings
  - 2. Creeping Red
  - 3. Illahee
  - 4. Olds
  - 5. Pennlawn
  - 6. Ranier
  - 7. Trinity
- E. Fescue, Tall
  - 1. Alta
  - 2. Goars
  - 3. Kentucky 31
- G. Ryegrass
  - 1. Annual
  - 2. Perennial

Southern Species

- A. Bahia
  - 1. Pensacola
- B. Bermuda
  - 1. Bayshore
  - 2. Bradley
  - 3. Everglades
  - 4. Ormond
  - 5. Texturf
  - 6. Tiffine
  - 7. Tiflawn
  - 8. Tifgreen
  - 9. Sunturf
  - 10. U-3
- C. Buffalo
  - 1. Ft. Collins
  - 2. Hays
  - 3. Nebraska
  - 4. Woodward
- D. Carpet
- E. Centipede
- F. St. Augustine
- G. Zoysia
  - 1. Meyer
  - 2. Emerald
  - 3. Flawn
  - 4. Ruglawn

6. Maintain the plots in a manner consistent with the needs of each species. Variables include different fertilizer needs, watering frequency, mowing height and frequency, and other cultural practices.

LANDSCAPE MAINTENANCE LABORATORY EXERCISE

Developing a Landscape Plan

Introduction

This laboratory exercise should not be started until you have studied some of the principles of landscape design and have studied actual examples of good and poor plans in your community. You may develop a landscape plan for your home grounds or for a problem site assigned by your teacher. No attempt has been made to include in this exercise the information you need to develop a plan. You will need to refer to a good reference book on landscaping to get the answers to questions which arise during the exercise.

Purpose

To provide a guide for students to use in developing a landscape plan.

Materials

1. Graph paper with one-eighth-, one-fourth-, or one-sixteenth-inch squares.
2. Drawing board, T-square, rulers, pencils, and tracing paper.
3. List of landscape symbols (attached).
4. Lists of shrubs, trees, ground covers, and vines grouped according to use and size. Descriptions of various plants and their growth habits.

Procedures

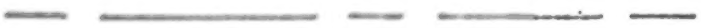
1. Inventorying and analyzing the present situation.
   a. Draw to scale a layout of the lot showing the house, walks, driveway, entrances, windows, and other structures.
   b. Locate on your drawing the plants presently growing on the lot.
2. Determining landscape needs.
   a. Take an inventory of family interests and the physical and environmental factors which should influence the final plan.
   b. List the landscape needs which the final plan should help meet.
3. Starting the landscape plan.
   a. On a fresh sheet of graph paper, draw to scale the lot, house and any other structures or plants which will be a part of the final plan.
   b. Divide lot into public, living, and service areas.
   c. Make and label small cutouts which can be moved from place to place on your plan before they are finally pasted or drawn on the plan.
   d. Prepare a table showing the characteristics, growth habits, and mature size of each plant you plan to use.
   e. Have the teacher or other class members evaluate your tentative plan.

4. Completing the plan.
   a. Draw in and label all additions to your plan including plant materials and landscape structures.
   b. Have your final plan checked by your teacher, your parents, and an experienced landscape expert.
   c. Develop a timetable for making the changes which must be made.
   d. Develop a list of materials to be purchased and approximate cost.

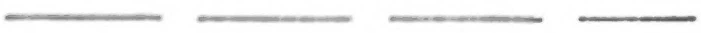
LANDSCAPE PLANNING SYMBOLS

Lines and positions

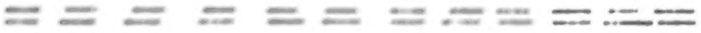
Boundaries



Proposed lines



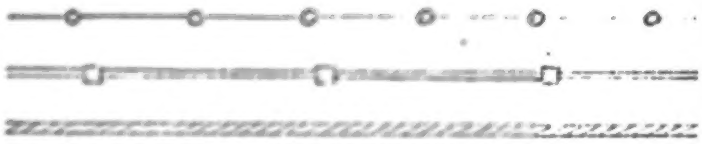
Underground pipes



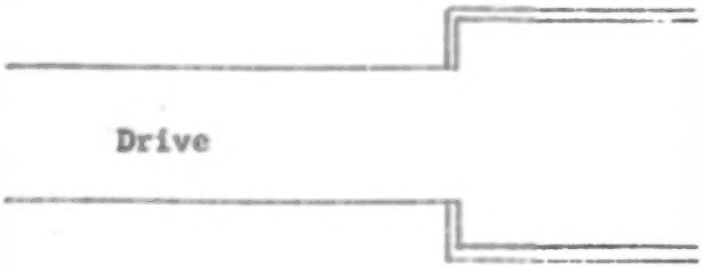
Power pole

Structures

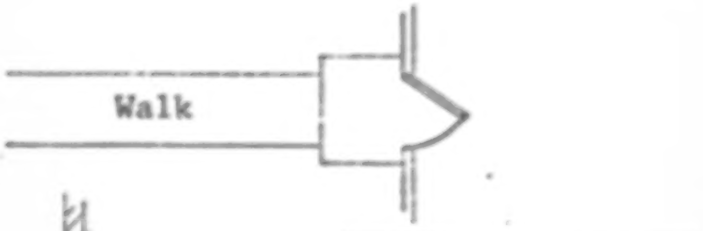
Fences



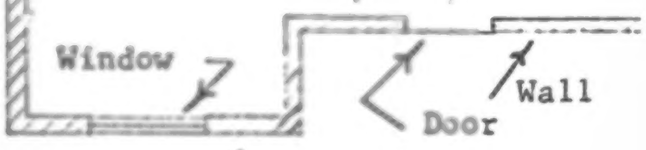
Drives



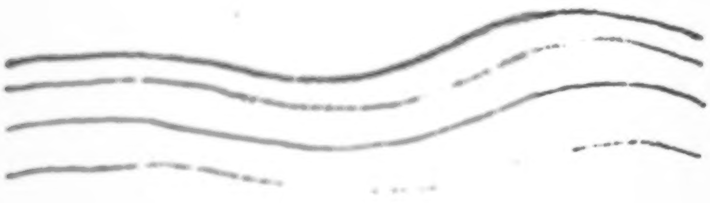
Walks



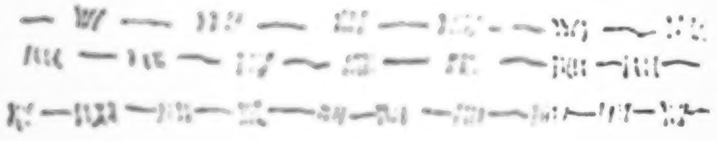
Buildings


Window
Door
Wall

Streams

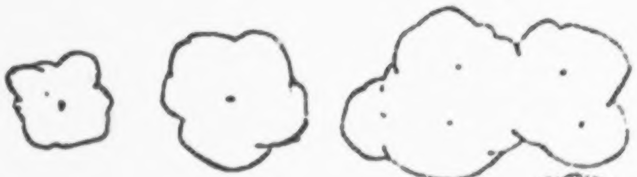


Swampy or wet ground

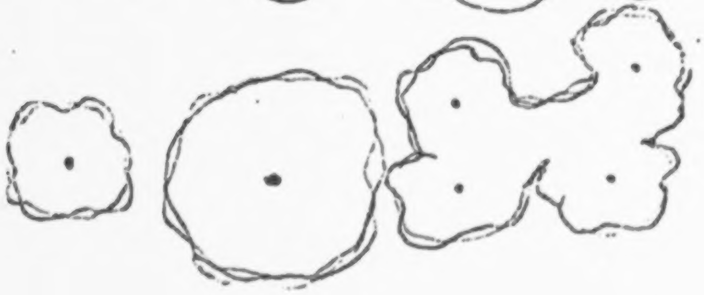


Plants

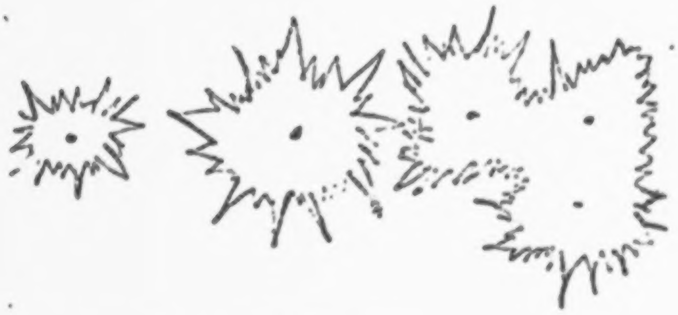
Shrubs (small, large, grouping)



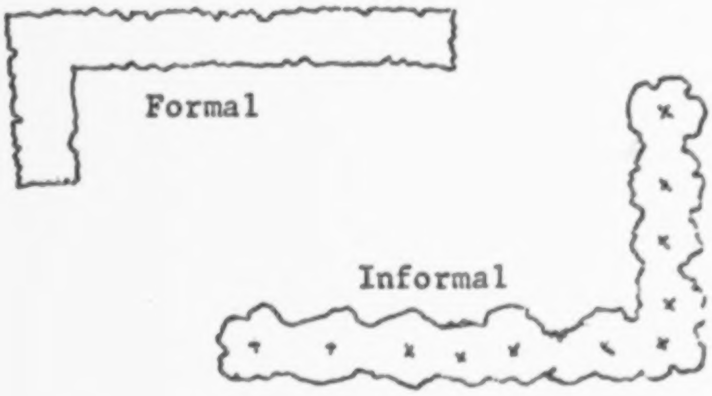
Trees (small, large, grouping)



Evergreens (small, large, grouping)



Hedge (formal and informal)

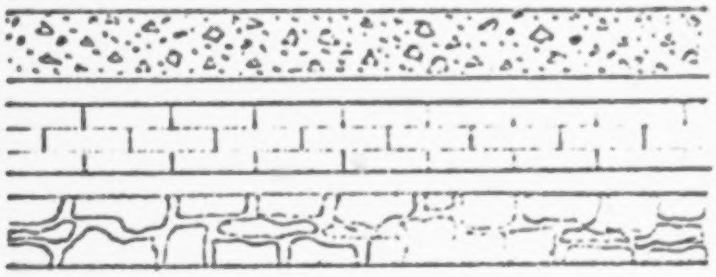

Formal
Informal

Masonry materials

Concrete

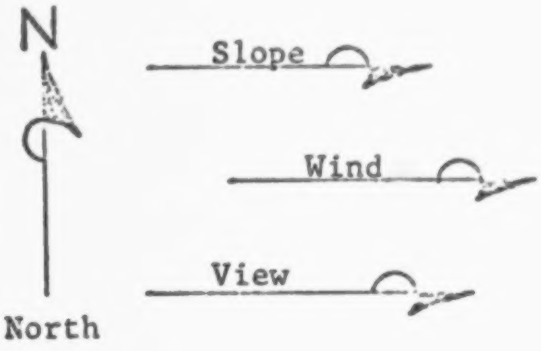
Brick

Flagstone

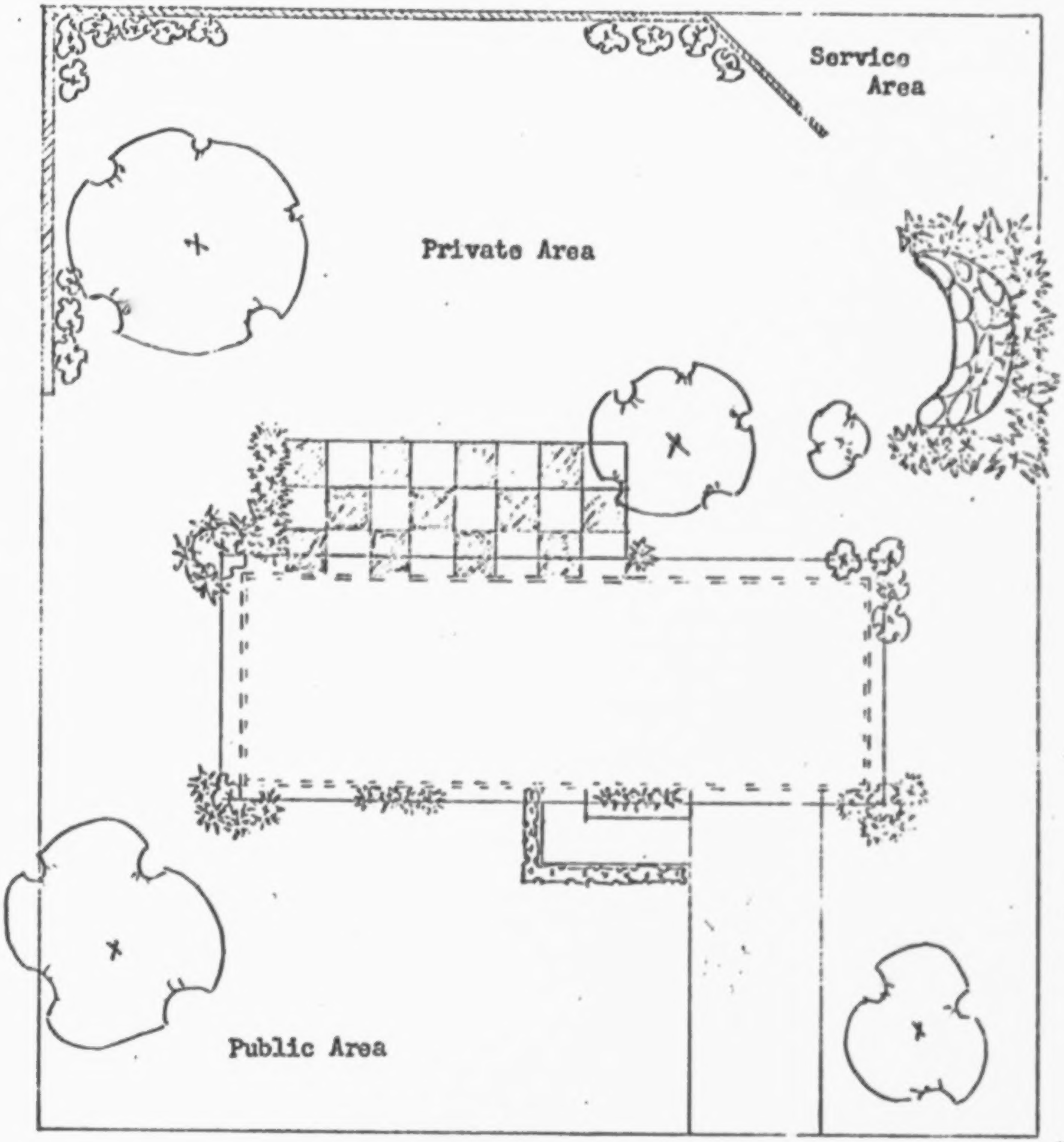


Directions

North
Slope
Wind
View


N
North
Slope
Wind
View

SAMPLE LANDSCAPE PLAN


Service
Area
Private Area
Public Area

LANDSCAPE MAINTENANCE LABORATORY EXERCISE

Balling and Burlapping Young Trees

Purpose

To develop the ability to ball and burlap young trees for transplanting.

Materials

1. Spade
2. Fertilizer
3. Burlap (opened gunny sacks)
4. Cord (for tying burlap)
5. Tags for marking trees and 7d nails

Procedures

1. Unless the tree is very small you will need to start preparations for moving one year in advance in the spring.
   a. Mark a circle around the tree with a radius of one-fourth of the height of the tree (a six-foot tree needs a circle with a radius of 18 inches.)
   b. Just outside this circle thrust the spade full depth, following the outline of the circle. This will cut the roots forcing the tree to make more of them near the trunk. (Figure 1.1)
   c. Sprinkle a cupful of fertilizer (all-purpose formula) on the ground inside the circle.
   d. Tag the tree to show it has been root pruned.
2. One year later when the ground thaws move the tree using the following procedure:
   a. Plan to save a soil mass (ball of earth) eight times the thickness of the trunk. Example: a 1 1/2-inch trunk needs a 12-inch ball.
   b. Dig a circular trench around the tree and undercut it as far as you can. (Figure 1.2)
   c. Fasten a corner of the burlap square (an opened gunny sack) around the trunk.
   d. Draw the burlap down one side to the base, tuck it under the tree as far as it will go, and push it into a tight roll.
   e. Working from the opposite side, shove a sharp spade under the tree to cut the lowest roots and tilt the ball away from you.
   f. Pick up the burlap from the bottom and finish the wrapping. Use nails to pin edges together.
   g. Use a second piece of burlap to wrap the ball completely.
   h. Loop heavy twine around and under the ball and tie it firmly.
   i. Lift the ball out of the hole by sliding a stout plank under it. Do not attempt to pull the ball out by the trunk.

Observations

1. Did pruning the roots affect the growth of the tree? __________
2. Were the roots concentrated around the base of the tree as a result of pruning the roots? ____________________
3. Did the soil remain compacted around the roots within the ball or become loosened? ______________________________

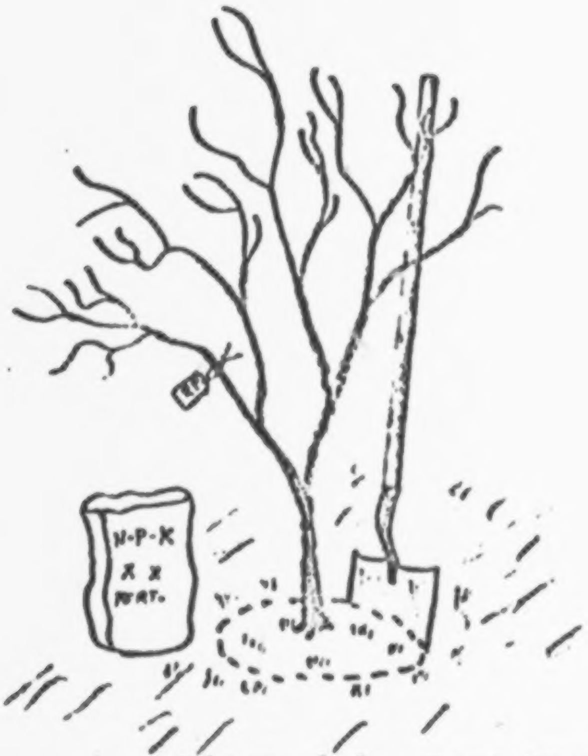


Figure 1.1.--Root Pruning

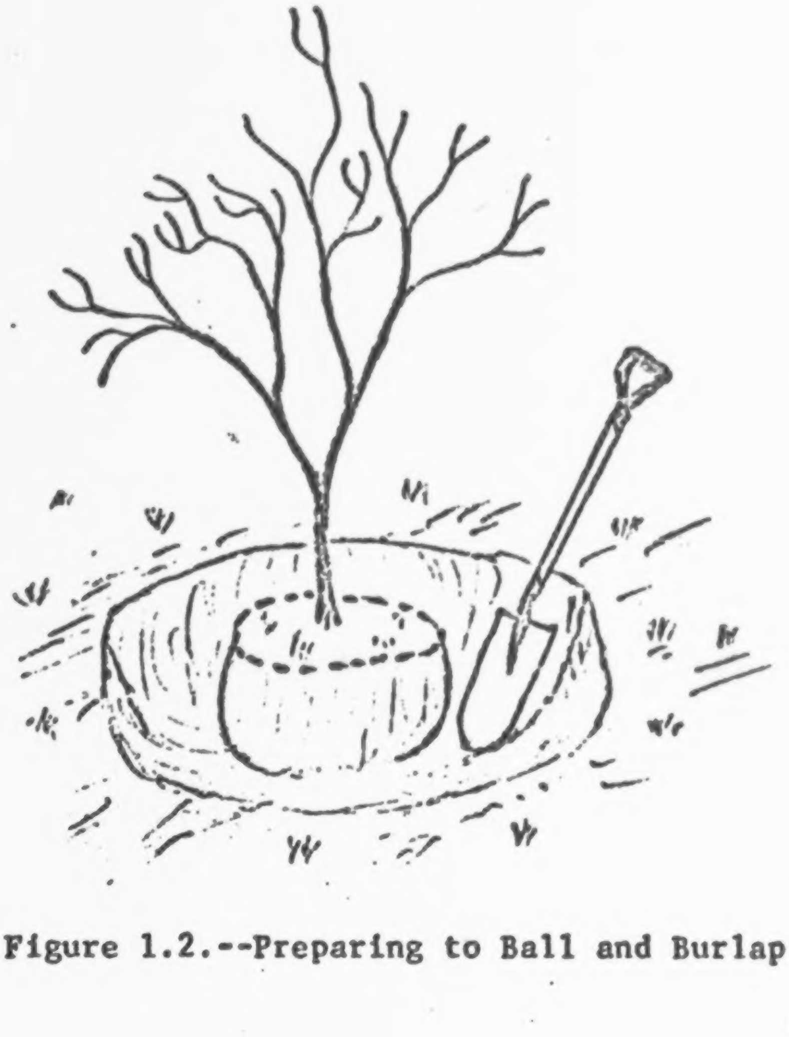


Figure 1.2.--Preparing to Ball and Burlap

LANDSCAPE MAINTENANCE LABORATORY EXERCISE

Planting a Balled and Burlapped Tree

Purpose

To develop a proficiency in planting balled and burlapped trees.

Materials

1. One balled and burlapped tree
2. One stake 4'-6' in length
3. Two lengths (16"-20") of rope, old garden hose, or pliable leather
4. A shovel
5. A sledge hammer

Procedures

1. Dig a hole with a 6-8 inch clearance all around the ball and deep enough so that the plant will be at the same depth as it was in the nursery.
2. Place 2-3 inches of fertile soil in the bottom of the hole.
3. Set the plant in place with the burlap still around the ball of earth. For large trees, use a tarpaulin to lower ball into hole. Do not handle tree by the trunk.
4. Cut the string and fold back the top of the burlap.
5. Partially fill the hole with fertile soil and thoroughly water the plant.
6. Finish filling the hole with just enough soil to leave a saucer-shape surface around the base of the tree.
7. Drive the stake into the ground alongside the tree and near the base of the tree.
8. Place the binding material (rope, leather, or hose) near the top and middle of the stake. Tie the binding material around the stake to form a figure 8. This serves as a support to hold the tree in place.
9. In poorly drained soils, place gravel in the bottom of the hole to insure proper drainage.

Observations

1. Is the tree the same height as it was before transplanting?

2. Is the tree set firmly in the ground and well supported?

3. Is the tree perfectly vertical? (In localities which have strong winds predominantly from one direction the tree may be leaned slightly into the wind direction.)

LANDSCAPE MAINTENANCE LABORATORY EXERCISE

Fertilizing Large Trees

Purpose

To develop an understanding of the need for fertilizing large trees and to develop the skill involved in performing the job.

Materials

1. A predetermined amount of 12-6-4 fertilizer
2. A soil auger (power or hand)

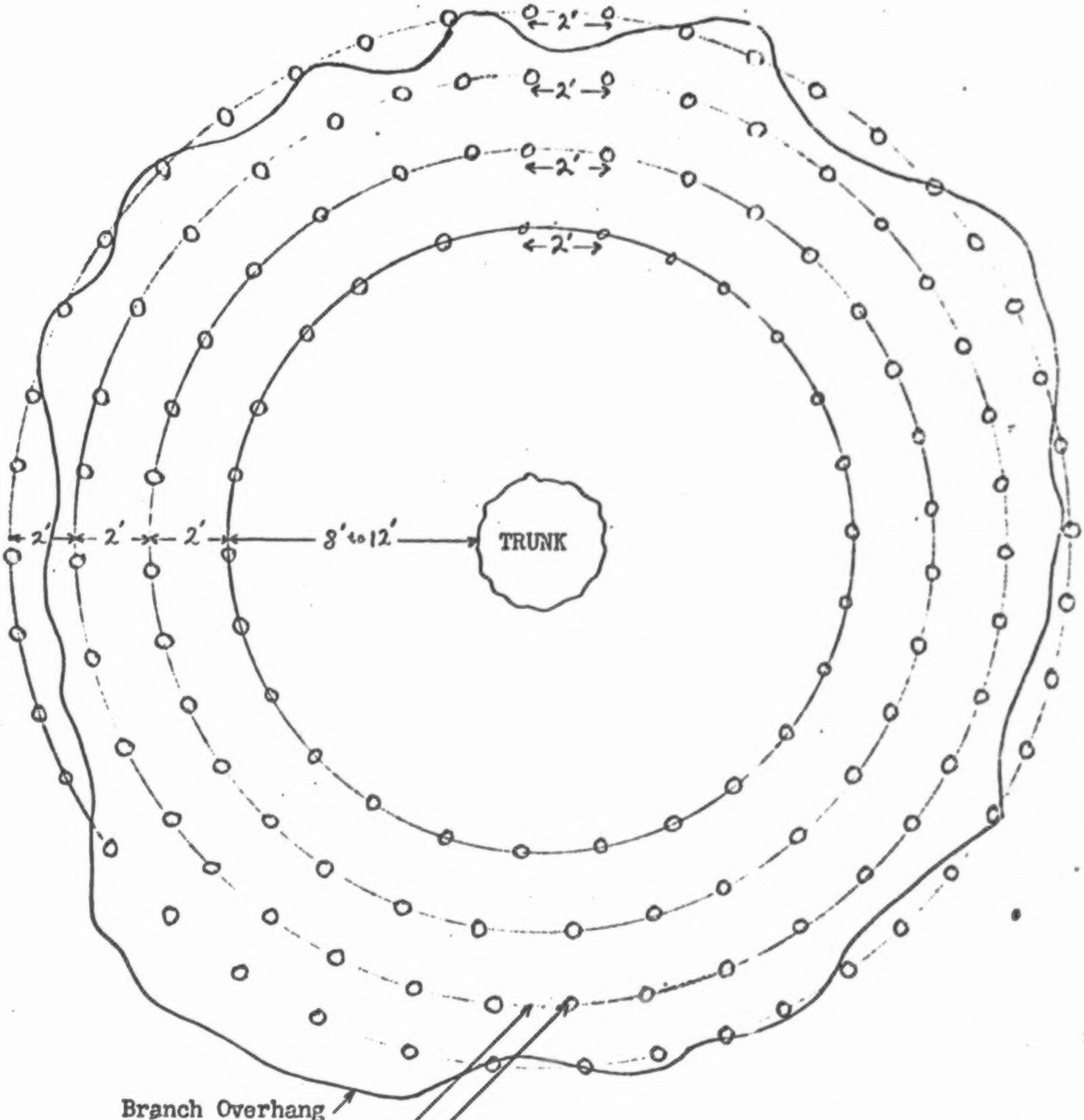
Procedures

1. Mark spots for holes in concentric circles two feet apart. Make the outer circle a few feet beyond the overhang of the tree's branches. Mark each inner circle two feet closer to the trunk with the innermost circle 8-12 feet from the trunk. (See figure 1.1)
2. Drill the holes with the power or hand auger 18 inches deep.
3. Determine the proper amount of fertilizer to be applied by allowing two pounds of 12-6-4 mixture for each inch of trunk diameter measured at a point approximately 60 inches above the ground.
4. Divide the total number of pounds to be used by the number of holes drilled and apply an equal amount of fertilizer per hole.
5. After placing fertilizer in holes, refill the holes with soil.
6. Water the soil long enough to apply one inch of water to the surface.

Observations

1. Does the foliage begin to darken after a period of two days? One week? Two weeks?

2. Does the foliage exhibit general characteristics of a healthy tree after a period of two weeks?


2'
2'
2'
2'
TRUNK
2'
2'
2'
8' to 12'

Branch Overhang

Concentric Circles

Fertilizer Holes

Figure 1.1 - Diagram of Pattern for Fertilizing Large Trees

LANDSCAPE MAINTENANCE LABORATORY EXERCISE

Pruning Shrubs

Purposes

1. To develop an understanding of the principles involved in pruning ornamental plants.
2. To develop the ability to prune shrubs to maintain normal growth and flowering.

Materials

Cutting tools such as hand pruning shears

Procedures

1. Keep the following factors in mind in pruning shrubs:
   a. Each kind of shrub should be pruned after its normal flowering period, indicating different shrubs will have to be pruned at different times.
   b. Late summer and fall flowering shrubs should be winter-/or early spring-pruned.
   c. Pruning the entire shrub back to the ground line should be resorted to only if the shrub is old and straggly or if the shrub is grown for its winter twig effect.
2. Prune the shrub back removing a maximum of one-third of the old wood in any one year.
   a. Figure A shows a three-to four-year-old shrub.
   b. Figure B shows proper pruning of shrub with subsequent growth (heading back effect).
   c. Figure C shows an improper method of heading back. This type of pruning will cause uneven flowering and an unnatural habit of growth.

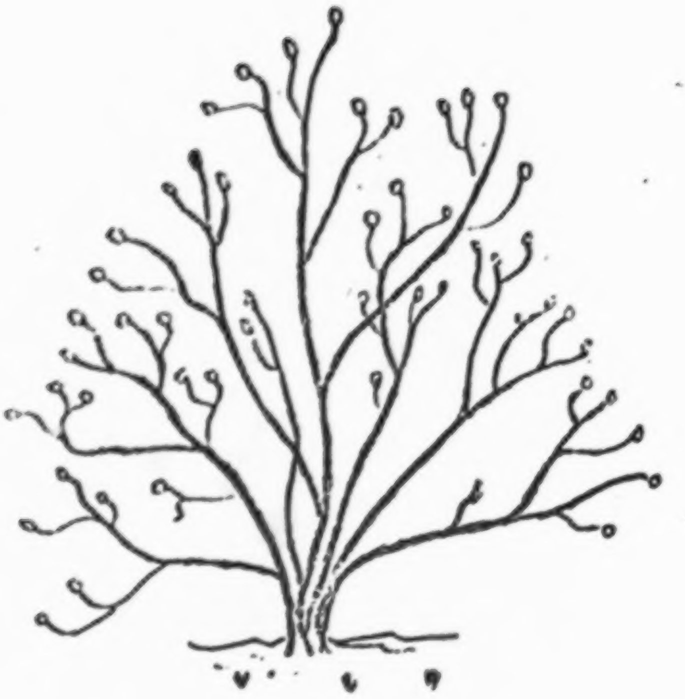


Figure A

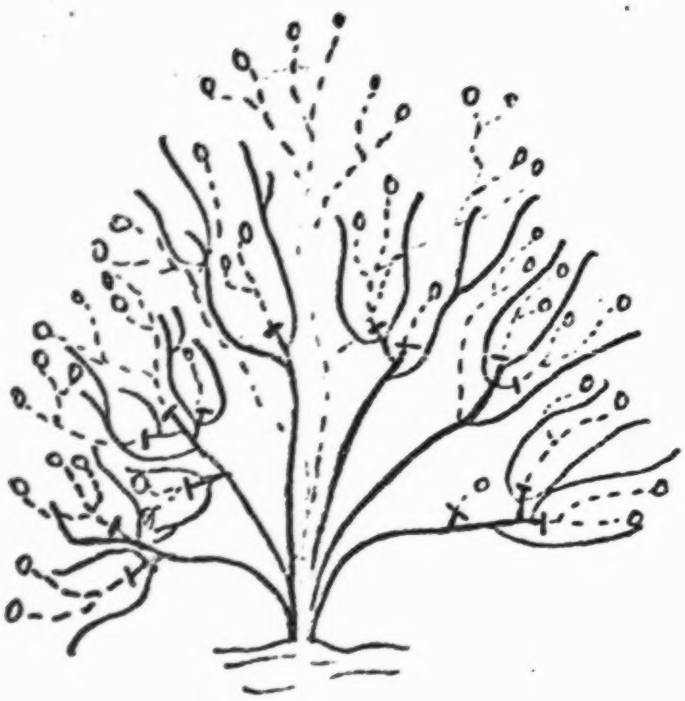


Figure B

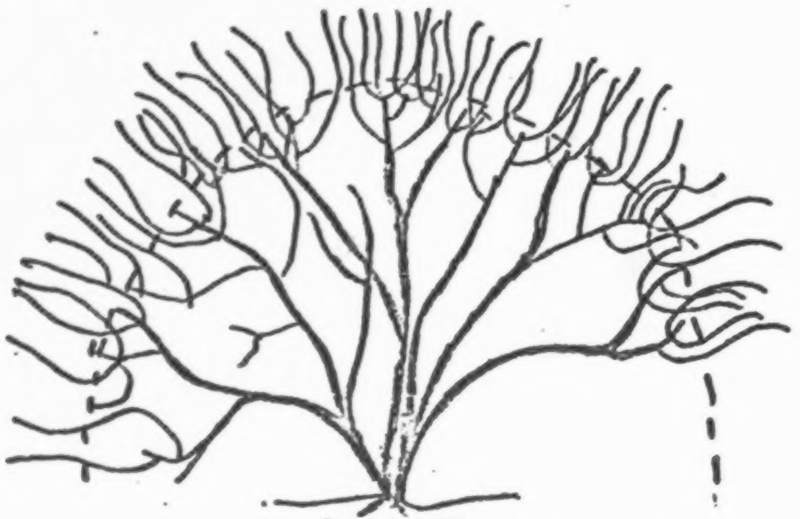


Figure C

LANDSCAPE MAINTENANCE LABORATORY EXERCISE

Pruning Hedges

Purposes

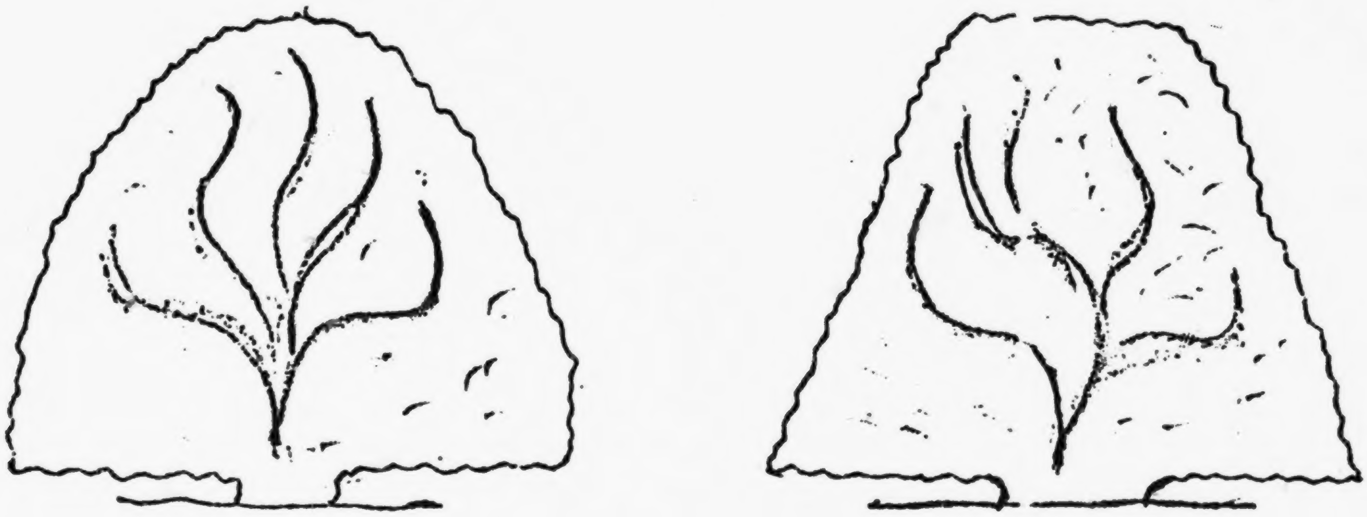
1. To develop an understanding of the principles involved in pruning ornamental plants.
2. To develop an understanding of the pruning practices used to maintain a compact habit of growth with hedges.

Materials

Shears or hedge clipper

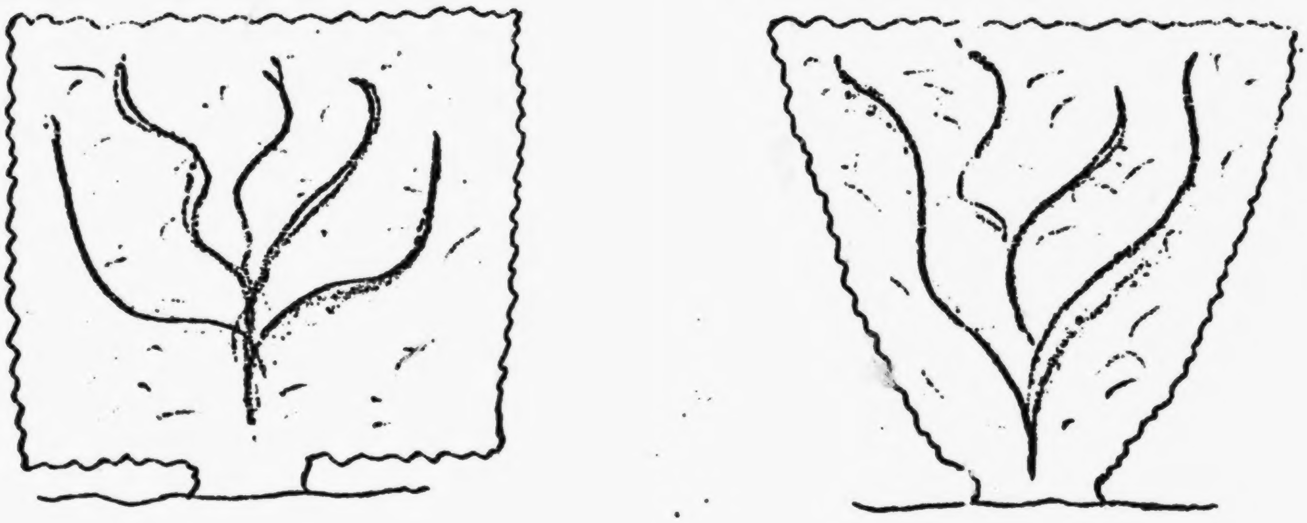
Procedures

1. Keep the following factors in mind in pruning hedges:
    a. Hedge pruning should be done several times during the growing season.
    b. The first pruning should be done just before growth starts in the spring. This pruning should consist of cutting back the hedge a little less than the desired dimensions so that it will not grow too rank.
    c. The last clipping should be six weeks prior to cold weather to permit new growth induced by clipping to mature properly.
    d. Slow-growing plants, such as evergreens, require only one clipping which is done after growth has started in the spring.
2. The shape to which the hedge is pruned determines its general appearance and compactness of growth. Figure A shows the right and wrong ways to prune a hedge. The objective is to permit as much light as possible to reach the lowest branches to stimulate vegetative growth.
3. Prune the hedge with the above factors in mind.



Good

Good



Fair

Poor

Figure A.--Hedge Shapes

LANDSCAPE MAINTENANCE LABORATORY EXERCISE

Pruning Mature Trees

Purposes

1. To develop an understanding of the principles involved in pruning ornamental plants.
2. To develop skills involved in the proper pruning of mature trees.

Materials

1. Cutting tools: lopping shears, hand saw, or power saw
2. Tree wound dressing (or suitable lead paint)

Procedures

1. Trees should be pruned in late winter or early spring.
2. Select desired limbs to be cut.
3. Undercut the limb a foot from the trunk of the tree until the saw binds. See Cut #1
4. The second cut is made about 2 inches past the first cut. This enables the limb to break without damaging the remaining bark. See Cut #2
5. The third cut is made parallel to and as close to the trunk of the tree as possible. Figure 1 shows the right and wrong way to remove large limbs.
6. Apply wound dressing to wounds two or more inches in diameter. If a commercial preparation is not available a good grade of lead paint (with lampblack added to make it less conspicuous on the tree) may be used. A new coat of dressing should be applied once a year until the wound heals.

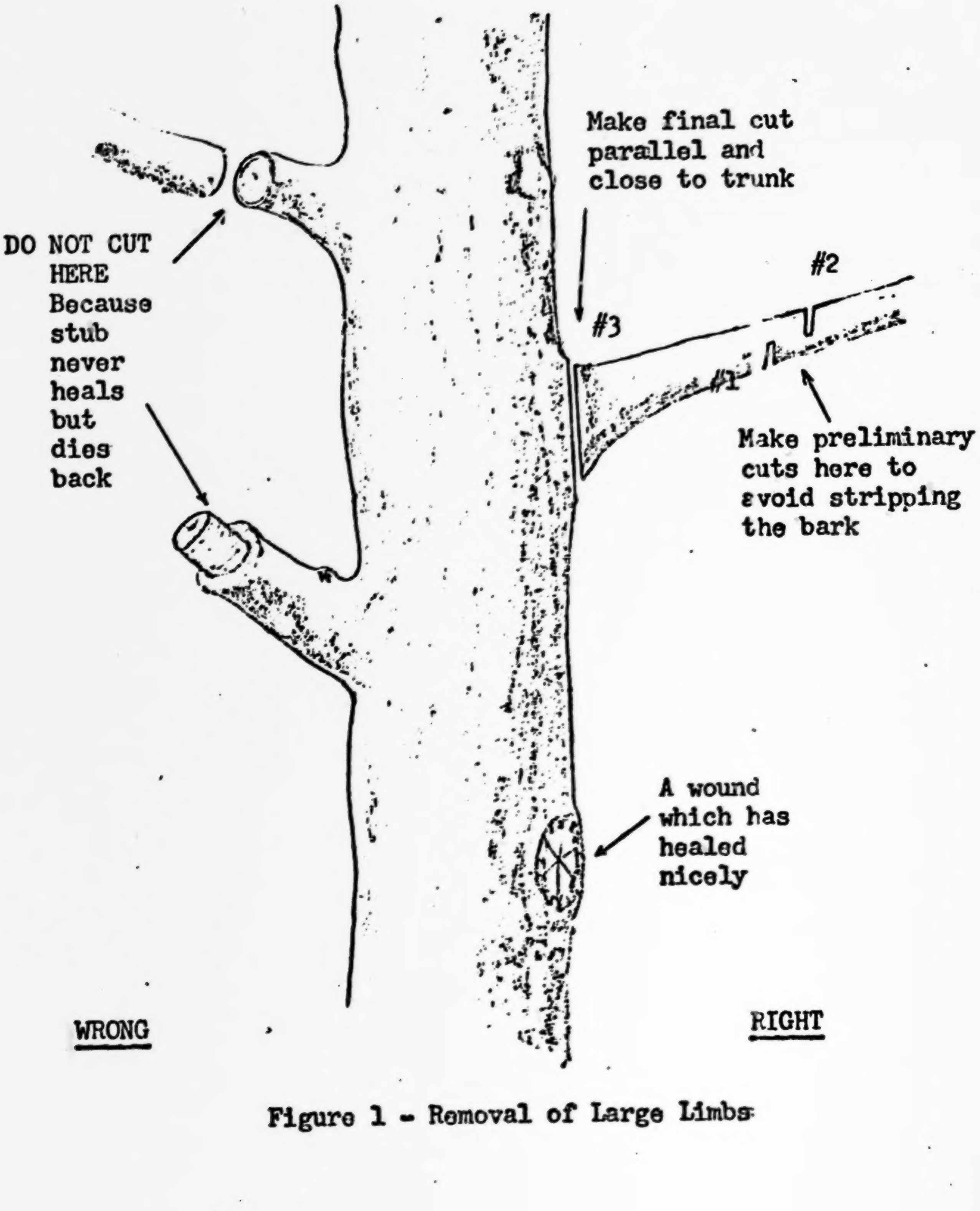

Make final cut parallel and close to trunk
DO NOT CUT HERE Because stub never heals but dies back
#2
#3
#1
Make preliminary cuts here to avoid stripping the bark
A wound which has healed nicely
WRONG
RIGHT

Figure 1 - Removal of Large Limbs

LANDSCAPE MAINTENANCE LABORATORY EXERCISE

Bracing Trees and Limbs

Purpose

To develop the knowledge and skill necessary to brace newly transplanted trees, old trees and weak limbs.

Procedures

1. Bracing trees (over two inches in diameter)
    a. For trees more than two inches thick at the trunk use three guy wires. (See Figure A)
    b. Anchor these wires to stakes driven in the ground around the tree at distances to make an equilateral triangle.
    c. Where the wires touch the trunk (just above a lower limb) run them through a section of old hose. This keeps the wire from cutting the bark.
    d. Tighten the guy wires so there is enough tension to hold the tree almost rigid in a gale.
2. Bracing trees (under two inches in diameter, newly planted)
    a. Select a stake (2 x 2 lumber) long enough to be driven into the ground two feet deep and still have enough stake above ground to reach halfway up the tree.
    b. Drive the stake into the ground as close to the trunk as possible on the windward side.
    c. Tie the tree to the stake in three places with leather, rope or other material which will not cut the bark. The trunk may be wrapped first and then tied with wire. (See Figure B)
3. Bracing weak limbs
    a. Limbs may become weak as the tree grows older and the limbs grow heavier. This is especially true for trees which have a major V-crotch at the first two limbs.
    b. If the limbs need bracing, they may be cabled or bolted or both. (See Figure C)
    c. To cable two limbs fasten an eye bolt through each limb parallel to the direction of pull. Next, fasten a steel cable to each eye bolt and tighten until snug.
    d. To brace a V-crotch by bolting, drill a hole slightly larger than the bolt through the major limbs at the base of the V-crotch. Insert a long bolt and tighten securely. It may be necessary to use extra large washers or special curved plates on each end of the bolt to keep the bolt from pulling through.

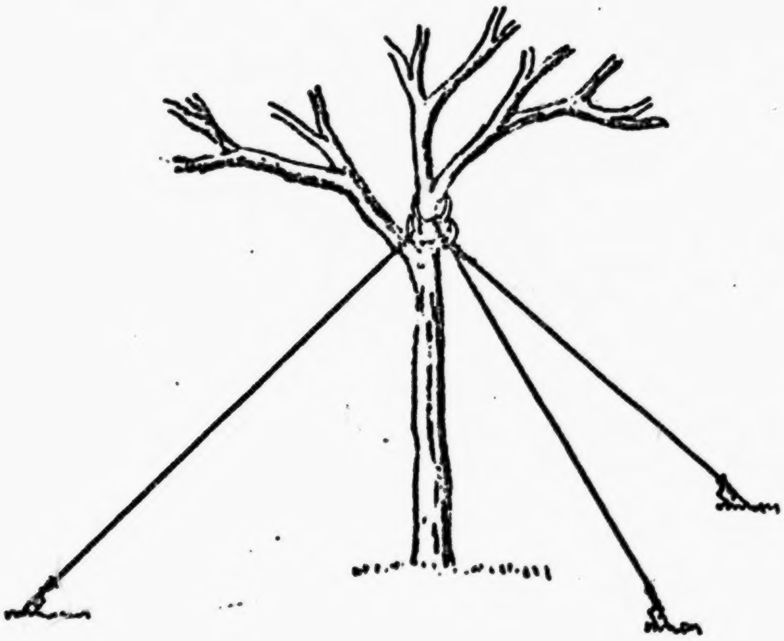


Figure A

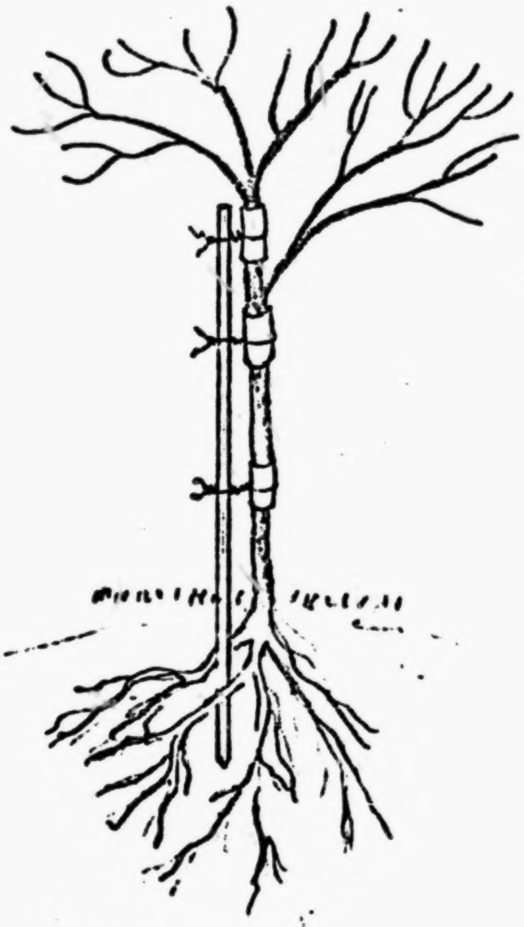


Figure B

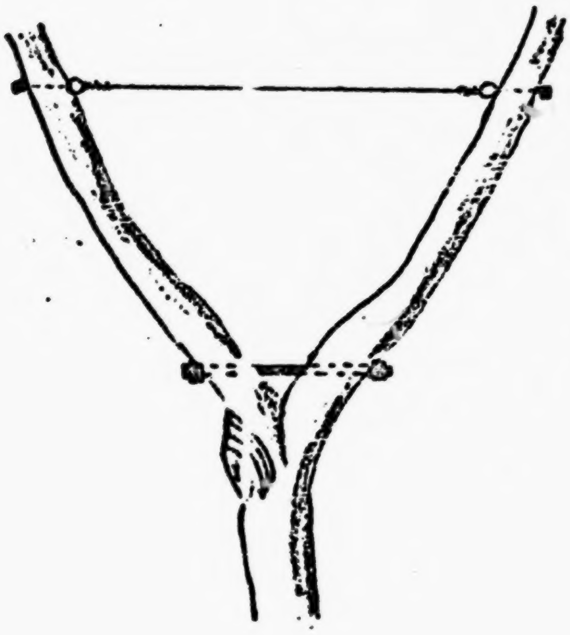


Figure C

LANDSCAPE MAINTENANCE LABORATORY EXERCISE

Espaliering

Introduction

Espaliering is the art of training a plant into a definite pattern. An espalier is a shrub or tree treated like a vine and trained to grow flat along a wire, railing or trellis. The wire, railing or trellis is also referred to as an espalier. Espaliers are many times grown along the side of buildings.

Dwarf fruit trees are popular espaliers. They are especially suitable for smaller gardens. Apples, pears, apricots, cherries, and plums are favorites for training as espaliers. Dwarf forms of all five trees are available.

Although fruit trees are usually not commercially grown as espaliers in the United States because of the extensive pruning labor required, espaliers are very attractive as ornamentals. Fruit trees are most often chosen and trained as espaliers because espaliering exposes a maximum of branch surface to the sun, and therefore enhances heavier flower and fruit production.

Espaliers are formed by bending and tying succulent shoots into a desired position and by proper pruning. The purpose of an espalier is to obtain some predetermined shape in order to achieve greater productivity, quality, ease of culture or beauty. Special attention must be given the espaliered plant in the formative years to obtain the desired shape.

Supports must be strong enough to support a fruit-laden espalier. They should also be built to last. Wood trellises should be treated with a preservative such as penta or copper naphthenate. Galvanized pipe can be used as posts and 14-gage galvanized wire stretched tightly on turnbuckles can be used as trellises. An outline of the procedure used to train a plant into a definite pattern is presented on the following two pages.

A. At planting time, start to train a carefully selected young tree.
   1. Cut off the top of the leader as shown in Figure 1.
   2. Leave three well placed buds or branches. (The two lower branches will be trained horizontally, the top branch or bud will become the leader.)
   3. Remove all other branches or buds.

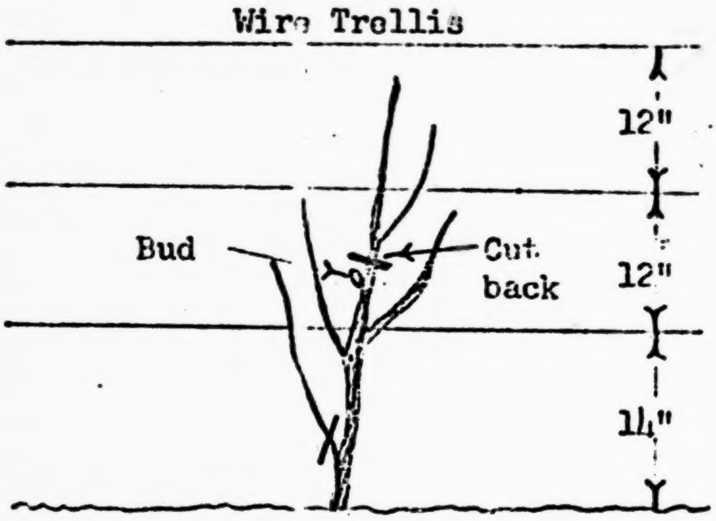

Wire Trellis
12"
Bud
Cut back
12"
14"

Figure 1. Training and pruning at planting time.

B. During the first growing season, gradually bring the bottom tier of branches to a horizontal position and straighten the vertical branch. Caution: Too rapid forcing of branches into position may cause injury.
   1. Remove all growth on the trunk below the bottom laterals.
   2. Don't pinch the bottom laterals.

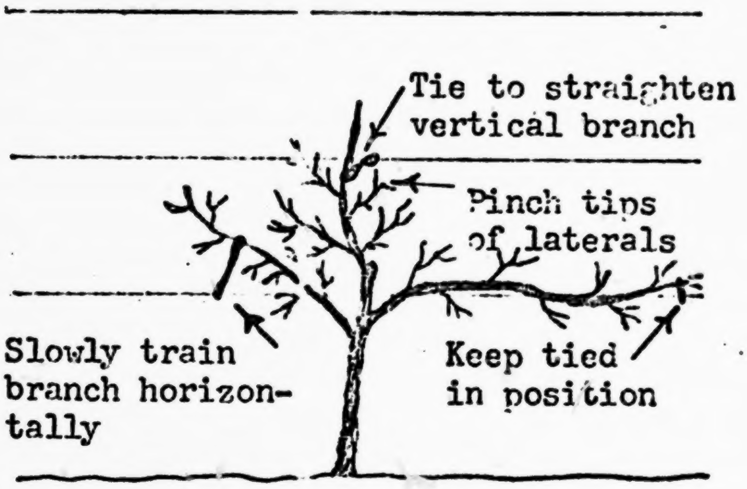

Tie to straighten vertical branch
Pinch tips of laterals
Slowly train branch horizontally
Keep tied in position

Figure 2. Training during the first growing season.

C. During the first dormant season, cut back the top of the leader below the middle wire.
   1. Keep the lower branch tips tied to the wire to keep the branches growing horizontally.
   2. Prune the terminals of the bottom branches only for balance.
   3. Cut back the vertical branch below the middle wire and retie. Cutting back the vertical branch below the second wire and pruning the laterals prepares the espalier for the second growing season.

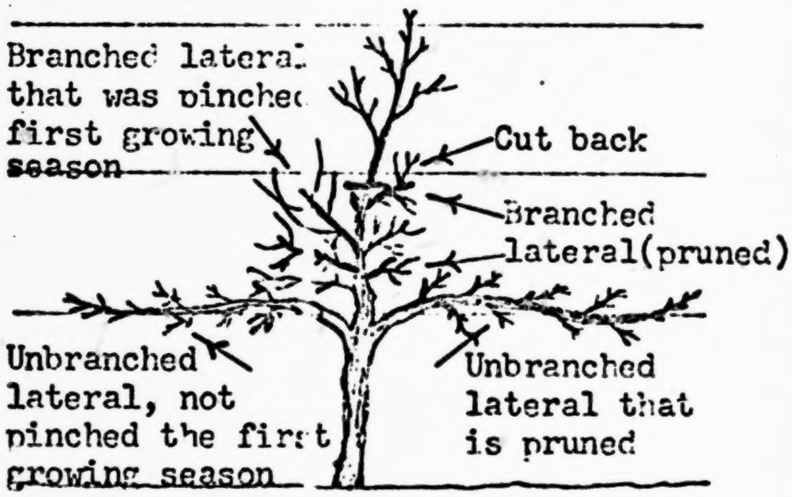

Branched lateral that was pinched first growing season
Cut back
Branched lateral(pruned)
Unbranched lateral, not pinched the first growing season
Unbranched lateral that is pruned

Figure 3. Training during the first dormant season.

D. During the second growing season, train the second tier branches in the same manner as the first tier branches were trained during the first growing season.
   1. Fruiting spurs will now begin to form at the base of all laterals below the second tier. These spurs will produce fruit next year.
   2. Cut back shoots on the laterals to three buds. Basal buds will become fruiting spurs.
   3. Tie and train second tier branches.

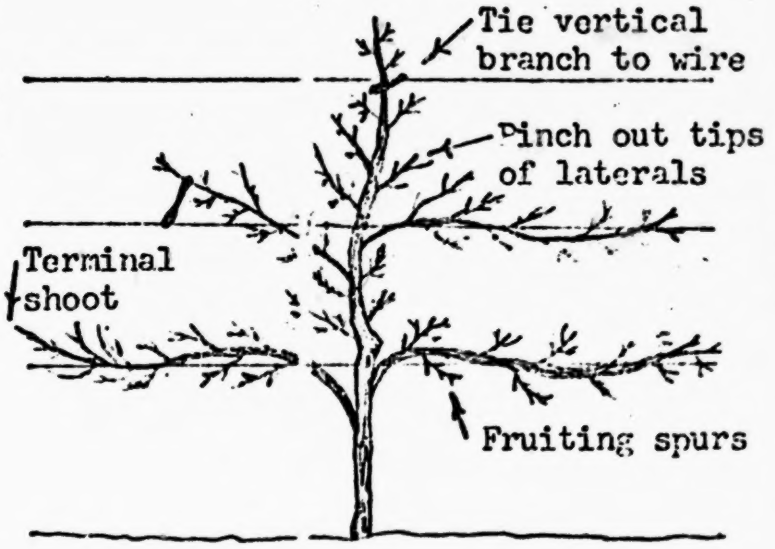

Tie vertical branch to wire
Pinch out tips of laterals
Terminal shoot
Fruiting spurs

Figure 4. Training during the second growing season.

E. During the second dormant season, cut back the vertical branch below top wire. Prune the second tier laterals in the same manner as the first tier laterals were pruned during the first dormant season.
   1. Cut back and retie the vertical branch to the top wire.
   2. Keep tips tied horizontally.

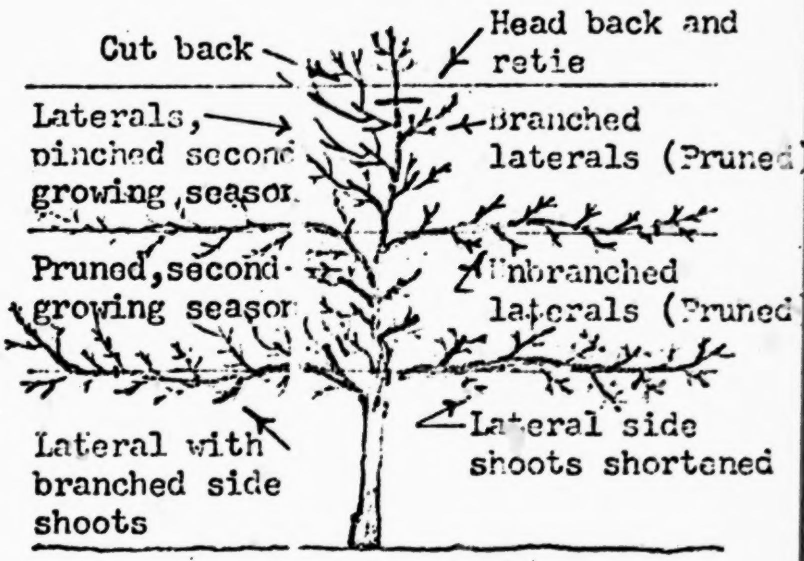
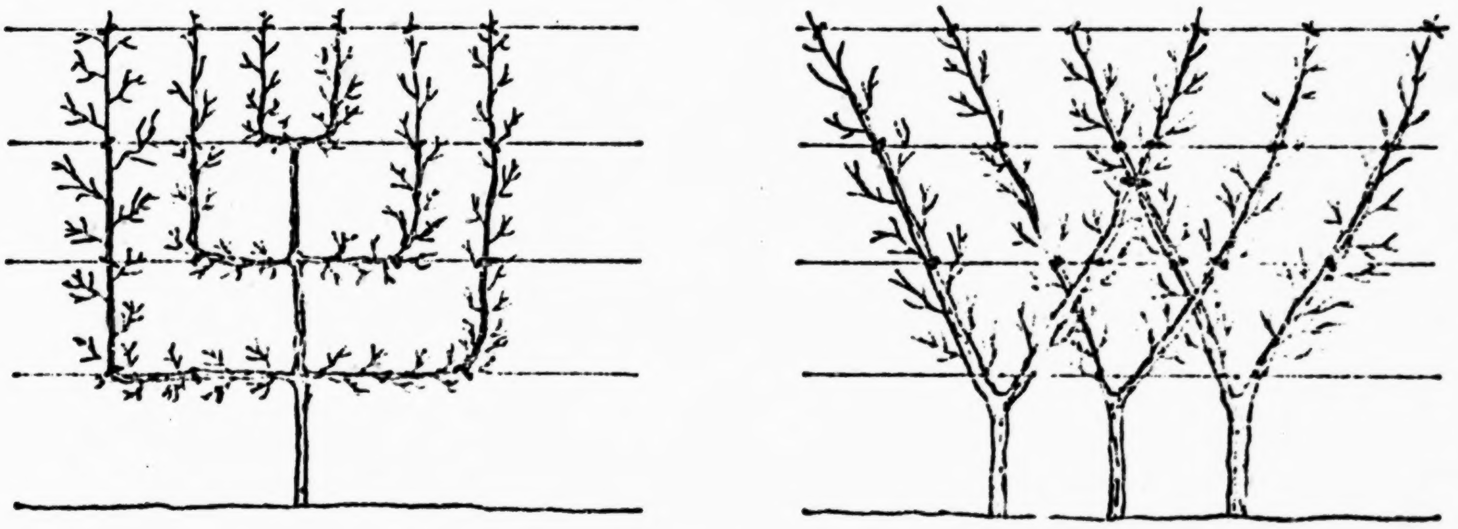

Cut back
Head back and retie
Laterals, pinched second growing season
Branched laterals (Pruned
Pruned, second growing season
Unbranched laterals (Pruned)
Lateral with branched side shoots
Lateral side shoots shortened

Figure 5. Training during the second dormant season.

F. Continue a similar training procedure in following years, fitting the tree to the space.



Other Shapes of Espaliers

PLANT PROPAGATION LABORATORY EXERCISE

Softwood Cuttings

Purpose

To demonstrate a method of cutting softwood taken from new growth or softwood at the tip of branches.

Materials

1. Knife
2. Fifteen 4" pots
3. Peat moss
4. Medium (sand or vermiculite)
5. Labels
6. Juniper, dogwood, lilac, spirea, azalea, or holly

Procedures

1. Place one-half inch of peat moss in bottom of the pots.
2. Fill pots with medium, one half inch from top.
3. Cut 15 tips three inches long just below node.
4. Remove all leaves except top three. Leave all petioles.
5. Make deep hole in center of pot.
6. Insert cutting three-fourths to one inch deep in medium.
7. Place completed pots in coldframe or hotbed and add water as often as needed.
8. Label as to variety.

Observations and Suggestions

1. Softwood cuttings are taken from both deciduous and evergreen woody plants.
2. Cuttings from deciduous plants are taken before or immediately after the new shoots have ceased to elongate.
3. Cuttings from broad-leaved evergreens are usually taken in the fall or early winter.
4. If plant material is ripe, it will break clean when snapped.
5. Test your cutting material before making cuttings to see if they will snap clean.

Questions

1. What are petioles ______________________________
____
2. Why do you use the tips of plants for softwood cuttings? ______
____
____
____
3. Why are the cuttings taken just below a node? ______________
____
____

PLANT PROPAGATION LABORATORY EXERCISE

Simple Layering

Purpose

To demonstrate a method of layering when the plant is low, sweeping, and can be bent to the ground easily. Simple layering can be used on plants that do not come true to type when grown from seed, do not graft easily, or do not root readily from stem, leaf, or rooting cuttings.

Materials

1. Peat
2. Sand
3. Knife
4. Wooden peg or wire wicket or stone
5. Rose, rhododendron, or honeysuckle plants

Procedures

1. Before making a simple layer, work peat and sand into the soil where the branch will be layered.
2. Begin the layering operation by wounding the branch.
3. Make a slanting cut two inches long on the upper side of the branch about 12 inches from the tip. Dust the cut with rooting stimulant.
4. Fasten the branch to the soil. Pin it down between the trunk and the cut with a wooden peg or wire wicket, or weight it with a stone.
5. After the branch is pinned to the soil, bend the tip upright. As you do this, twist the branch as if you were turning a screwdriver one-half a turn. This will open the cut.
6. Place a second peg or pin over the branch directly at the point of the cut.
7. Cover the pegged branch with several inches of soil into which peat and sand have been worked.
8. Mound the soil around the upturned stem so the wound is three or four inches underground. Pack the covering soil firmly.
9. Mulch the soil over the layered branch with straw or leaves. Water frequently; keep the covering soil moist.

Observations

When the layer has formed roots--the following spring for spring-layered branches or the second spring for fall-layered branches--cut the rooted branch free from the parent plant.

Leave the new plant in place for two or three weeks after it is severed from the plant. This will give it time to recover from the shock of being cut. Then transplant it to a nursery bed, where it should be tended carefully for a year.

Note: Simple Layering is employed only when the branch is low, sweeping and can be bent to the ground easily. It is layered by burying the wounded part in the ground.

Questions

1. Where did new roots develop on the plant propagated by simple layering? ______________________________

   ____

2. What effects do rooting stimulants have on plants propagated by layerage? ______________________________

   ____

   ____

3. Name three other plants which could be easily propagated by layerage? ______________________________

   ____

PLANT PROPAGATION LABORATORY EXERCISE

Air Layering

Purpose

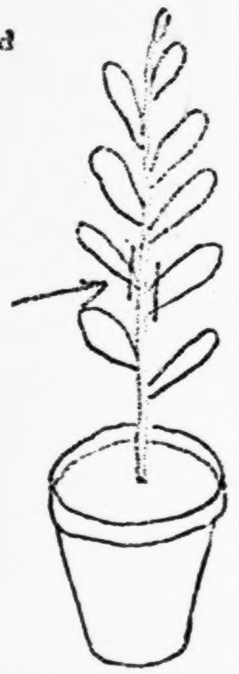
1. To show how roots are formed by air layering.
2. To show how to reproduce by air layering plants that are too large to root.
3. To show how to reproduce by air layering plants that do not readily root in a propagating bench.

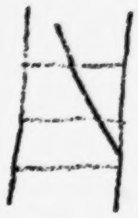
Materials

1. One or two ficus plants that have a minimum of seven to eight leaves each (Alternate use: philodendron or croton)
2. Rooting compound (hormodin two or cutstart xx)
3. Wet sphagnum moss--100 percent saturated (Soak in water 24 hours)
4. Aluminum foil
5. A sharp knife
6. Small squeeze bottle
7. Pots for planting new plants

Procedures

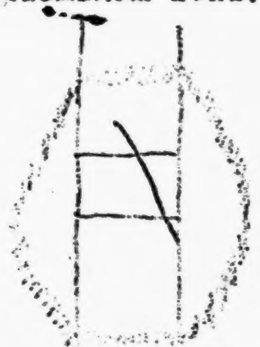
1. Select a ficus (rubber) plant which has a minimum of seven to eight leaves.
2. Cut off one or two middle leaves in the semi-hardwood or green tissue even with the stem. This will allow room to work.
3. Make a 45-60 degree angle cut upward through a node. The cut should be approximately three-fourths the diameter of the stem.





4. Carefully open the cut slightly. Do not break the stem. Dust the rooting compound (H_2) into the cut with the squeeze bottle.
5. Take a handful of wet sphagnum moss, press the sphagnum moss upward around the cut and squeeze out the excess water. The wet sphagnum moss should completely cover the cut. It should form a ball approximately two and one-half to three inches in diameter at the widest point and be three to three and one-half inches in length.

6. Secure a double layer of aluminum foil and cover the entire mass of wet sphagnum moss. Squeeze at the bottom and the top to eliminate light and prevent loss of moisture. Black plastic may be used in place of aluminum foil.



7. Maintain the plant at an optimum 80°-85° F. temperature. At 75° F. the plant will root, but it will take longer.
8. At the end of 30 days, remove the foil and check for root formation. If roots are present and well developed, they will be growing out of the sphagnum.
9. If the plant is well rooted, cut it off below the sphagnum and pot it up.

Observations and Questions

1. Observe the parent plant for two to three weeks. What changes can you observe? ______________________________

   ____

   ____

2. What was the effect on the parent plant of removing the upper portion? ______________________________

   ____

3. List the observed differences between the parent plant and the newly rooted plant. ______________________________

   ____

   ____

   ____

PLANT PROPAGATION LABORATORY EXERCISE

Rooting of Kalanchoe Pinnata (Bryophyllum)

Purpose

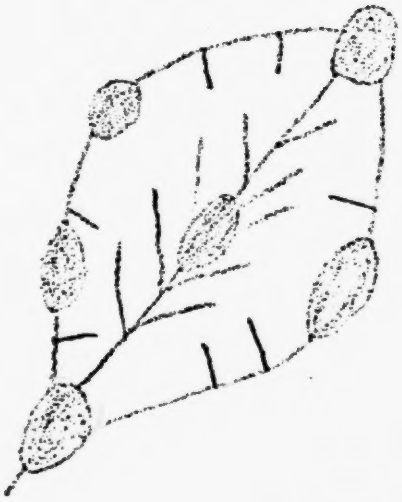
To show the effects of rooting Bryophyllum by leaf cuttings and terminal stem cuttings.

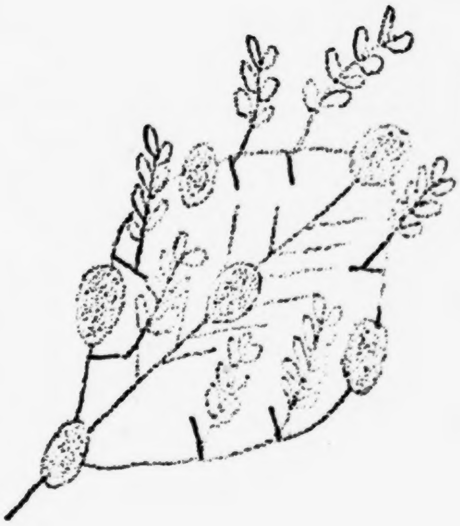
Materials

1. Rooting medium of sand or 65 percent peat moss and 35 percent sand
2. Six or eight Bryophyllum plants

Procedures

1. Take six or eight terminal stem cuttings. Stick them in sand or in a mixture of 65 percent peat moss and 35 percent sand.
2. Take six or eight Bryophyllum leaves and make one-half inch cuts or slits around the margins of the leaf. Lay these leaves on the surface of the medium. Then place just enough medium on the leaves to keep them in contact with the medium.





Questions

1. What was the result of sticking the terminal stem cuttings? ____

   ____
2. Notice the multiple growth on the leaves where the cuts were made. What causes the multiple plant development? ____________

   ____
3. Can this phenomenon be duplicated in most other plants? ________

   ____

PLANT PROPAGATION LABORATORY EXERCISE

Bud and Cleft Grafting

Purpose

To demonstrate the methods of bud and cleft grafting.

Materials

1. One very sharp knife
2. One grafting tool
3. Several rubber bands or a narrow strip of white sheeting
4. Grafting wax or tree coating compound
5. Several bud sticks
6. Several pieces of stock about 3/16 to 3/8 inches in diameter for budding and 2 to 3 inches in diameter for cleft grafting. The length should be at least 3'.
7. Several wedge-shaped scions

Part I--Bud Grafts

Procedures

1. Cut the bud sticks from the desired variety. The buds should be plump but dormant. Cut off the leaf about one-fourth of an inch from the bud. The piece of leaf stem that is left protects the bud and is useful as a handle for holding the bud. (Figure 1)
2. Using a very sharp knife, make a T-shaped cut in the bark of the stock. Begin the cut of the T near the ground line and cut upward about one inch. Then make the crosscut at the top of the vertical cut. The crosscut should extend about one-third of the way around the stock. When making the T, cut only through the bark, not into the wood (Figure 2 & 3)
3. Use the point of your knife to lift the bark along both sides of the vertical cut. (Figure 4)
4. Now cut the bud. Start the cut about one-fourth of an inch below the bud. (Figure 1) Cut under the bud only deep enough to take a thin sliver of wood. After the knife blade passes beneath the bud, angle the cut outward to remove the bud with a shield of bark about three-fourths of an inch long.
5. Insert the lower part of the bud shield into the T cut. Then push it down so the cut surface of the shield is flat against the wood of the stock. (Figure 5)
6. The bud shield should be completely enclosed in the T cut. If part of the shield protrudes from the top of the T, cut it off. (Figure 6)
7. After the bud is inserted, wrap the cut with a piece of rubber band or a narrow strip of white sheeting. (Figure 7)
8. Take three or four turns below the bud and again above the bud. Do not cover the bud with wrapping.

9. Three to five weeks later, cut the wrapping away; the bud should be united with the stock in this time.
   Note: Make bud grafts any time during the growing season when the bark of the stock will peel easily from the wood and dormant buds are available.
10. Buds usually remain dormant until the next season. In early spring, cut off the top of the stock plant just above the bud. This will force the bud to sprout; all growth from the bud will be similar to the bud source plant. (Figure 8)

Part II--Cleft Grafts

Procedures

1. To prepare the stock, saw it off squarely at the point where you wish the graft to be. With a grafting tool, split the end of the stock to a depth of two or three inches. (Figure 9) Place the wedge end of the tool in the split to hold it open. (Figure 10)
2. Now prepare the scions. With a sharp knife, carefully trim the butt of each scion to the shape of a wedge. Begin the cuts on each side of the lowest bud. The wedge should be bevelled in two directions with the wood on the lowest bud side a little thicker than the opposite side. (Figure 11)
3. Insert the scions in the split stock, with the lowest bud to the outside. (Figure 12) The cambium layers of the stock and scion should be in contact near the outside edge. (Figure 13) Figure 14 shows the incorrect way to place scions. On the lower side the cambium layers arn't matched and on the opposite side the scion has the beveled side to the outside and it should be on the inside.
4. When the scions are in place remove the wedge (Figure 15) and coat the wound with tree dressing compound. (Figure 16) Pressure from the split stock should be sufficient to hold the scions tightly.

Observations and suggestions

At the end of the first growing season, inspect the scions and cut off the weaker of the two. Cover the stub of the weaker scion with tree coating compound.

Questions.

1. What is grafting? ____________________
   ____
   ____
2. What are the two basic kinds of grafts? ____________________
   ____
   ____
3. What is the graft union? ____________________
   ____
   ____

4. What is meant by graft incompatibility? ______________________

5. What factors influence successful grafting? ______________________

6. What are the reasons for grafting? ______________________

7. What is budding? ______________________

8. When is the best time for grafting? Why? ______________________

9. How does cleft grafting differ from stub grafting? ______________________

10. What is bridge grafting? ______________________

11. What are some limitations of grafting? ______________________

12. How do the scion and the stock grow together? ______________________

13. Should the dimeter of the stock be greater than that of the scion? Why or why not? ______________________

14. What is the primary function of waxes in grafting? ______________________

15. What is the main advantage of cleft grafting? ______________________

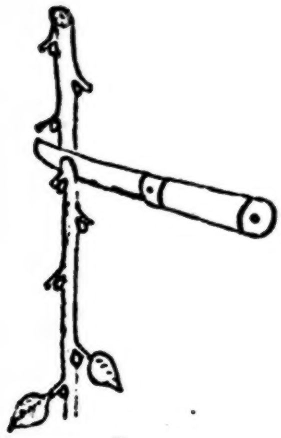
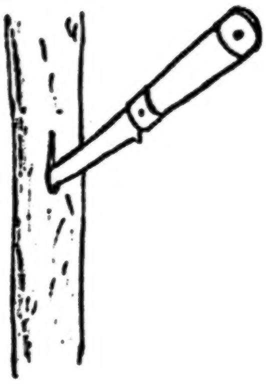


Figure 1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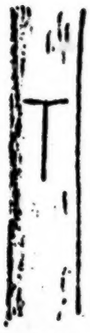
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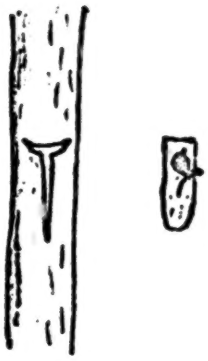
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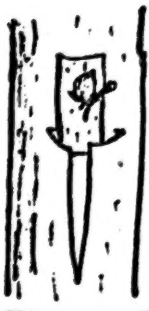
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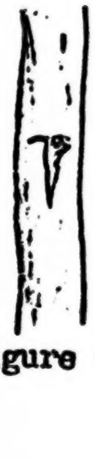
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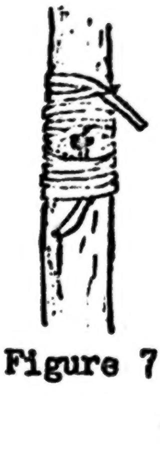
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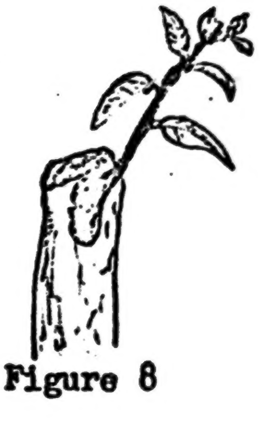
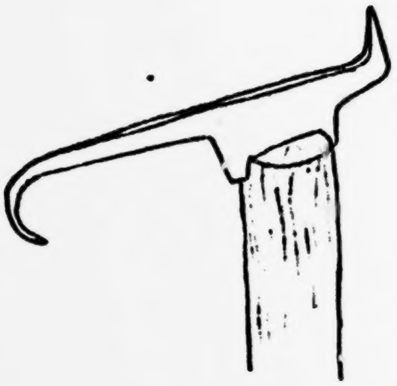


Figure 8



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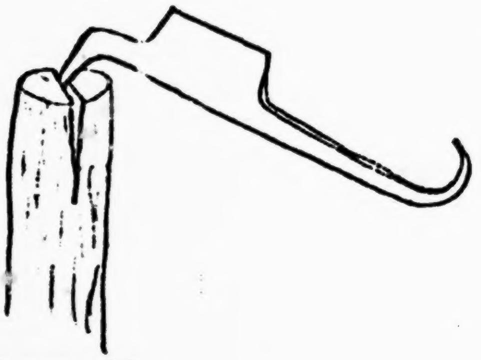


Figure 10

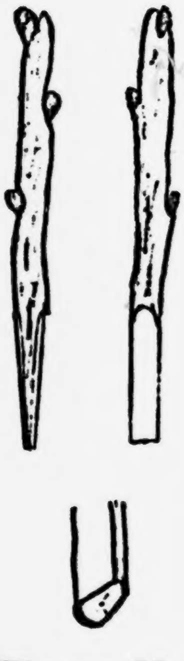
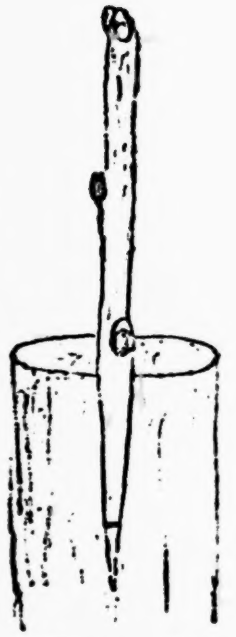


Figure 11



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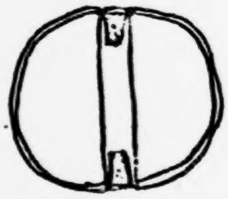


Figure 13

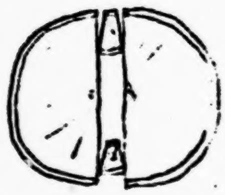


Figure 14

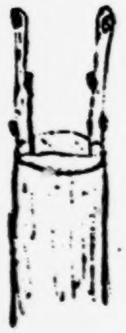


Figure 15

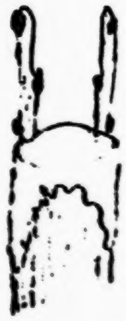


Figure 16

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Seed Germination in Different Media

Purpose

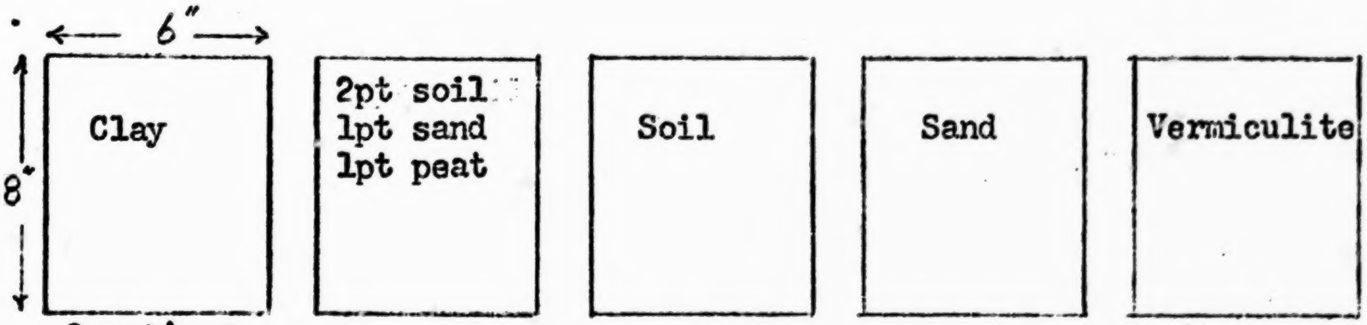
To show the effects of different media on the rate of seed germination.

Materials

1. Tomato, corn, marigold, snapdragon, or aster seeds
2. Five small seed flats 6" x 8"
3. Samples of media to fill flats:
   - a. Clay
   - b. Mixture of two parts soil, one part sand, and one part peat
   - c. Soil
   - d. Sand
   - e. Vermiculite

Procedures

1. Construct five 6" x 8" flats.
2. Prepare media by crushing lumps and mixing when necessary.
3. Fill flats with five different media.
4. Firm media and mark off furrows to a depth of three times the diameter of the seed.
5. Plant seeds in clay media.
6. Plant seeds in two parts soil, one part sand, and one part peat media.
7. Plant seeds in soil media.
8. Plant seeds in vermiculite media.
9. Observe seed germination and growth and record results at weekly intervals.



Questions

1. In which of the five media did the seeds germinate and grow best?
2. Why is a clay soil good for holding water, whereas sand is not?
3. How did the seeds germinate and grow in vermiculite? ________

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Pre-Soaking Seed

Purpose

To show the effects of pre-soaking on seed germination and seedling emergence.

Materials

1. Fifty each of tomato, corn, and sweet pea seeds
2. Three seed flats with a media mixture of two parts soil, one part sand, and one part peat moss by volume
3. Four petri dishes with covers

Procedures

1. Soak ten of each of the three kinds of seeds in one petri dish for 24 hours. Seeds should be completely covered with distilled water. (Tap water can be used if distilled water is not available.)
2. Soak ten more of each kind of seeds in a petri dish at intervals of 12, 18, and 23 hours later. Ten of each of the three kinds of seeds should not be soaked. These seeds will serve as a check.
3. Plant the seeds that have soaked for 24, 12, 6, and 1 hour at the *same time. Remove the excess water by placing the seeds on* paper towels. On the average, plant to a depth of three times the diameter of the seed.

Corn

Length of soaking

24 hrs.	1 hr.
12 hrs.	None
6 hrs.	

Sweet Pea

Length of soaking

24 hrs.	1 hr.
12 hrs.	None
6 hrs.	

Tomato

Length of soaking

24 hrs.	1 hr.
12 hrs.	None
6 hrs.	

4. Keep the media in which the seeds are planted uniformly moist and in a warm place. This can be done by moistening the medium in the seed flats after sowing and then putting a cover over them so the surface does not dry, or the seed flats can be left uncovered and placed under a misting system.

Questions

1. Which of the pre-soaked groups of tomato seeds germinated and emerged first? ______________________ Last? ______________
2. Which of the pre-soaked groups of corn seeds germinated and emerged first? ______________________ Last? ______________
3. Which of the pre-soaked groups of sweet pea seeds germinated and emerged first? ______________________ Last? ______________

4. Account for or explain the different rates of germination in each seed group? ____
____
____
____

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Effects of Different Media on Rooting

Purpose

To show how rooting of terminal cuttings is influenced by different media.

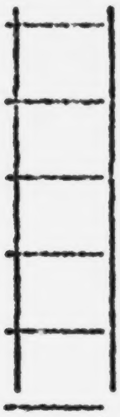
Materials

1. Five media and media mixes sufficient to fill five flats with the following:
   a. Perlite
   b. Vermiculite
   c. Soil
   d. Mix of 35 percent sand and 65 percent peat moss
   e. Mix of 70 percent peat moss and 30 percent perlite

2. Twenty-five terminal cuttings of chrysanthemums, philodendrons, geraniums, or carnations
3. Five flats

Procedures

1. Fill each flat to a depth of 4-6" with different media or media mixes as follows:



Perlite

Vermiculite

Soil

Mix of 35 percent sand and 65 percent peatmoss

Mix of 30 percent perlite and 70 percent peatmoss

2. Thoroughly water each media 24 hours prior to the time the cuttings are to be stuck.
3. Ask the instructor to demonstrate the procedure for making terminal cuttings on one of the following plants: chrysanthemums, philodendrons, geraniums, or carnations.
4. Select one of the above plants, make the cuttings and stick five cuttings into each media or media mix. The cuttings should be stuck immediately after being severed from the parent plant. If this cannot be done, the cuttings should be syringed and kept moist to prevent wilting.

5. In the event that the cuttings are not under a mist, syringe at least once per hour for two days to give the plants a good start.

6. Label each flat. Include date, name of cutting, and rooting media.
7. During the second to the fourteenth day, watering methods will vary with weather conditions. During the summer the cuttings should be watered-in well and then misted periodically for several days after planting. This reduces wilting and allows the cuttings to start in growth more rapidly. When planted during the winter the cuttings should be spot-watered, definitely leaving dry areas between plants. This allows the soil to dry more rapidly, and root growth will be faster.

Observations

1. Check for rate and percent of rooting at the end of the first ten days by carefully removing one or two plants from each media mix. Calloused tissue and a small number of primary roots should have formed.
2. Compare and rank the rate and percent of rooting in each media or media mix, and record your observations in the tables below. Carefully replace the cuttings after observation.

Rate of Rooting

		Media or Media Mix	
		10-Day	14-Day
Fastest rooting	1st		
	2nd		
	3rd		
	4th		
Slowest rooting	5th		

Percent of Rooting

		Media or Media Mix	
		10-Day	14-Day
Highest percent	1st		
	2nd		
	3rd		
	4th		
Lowest percent	5th		

3. Check again for rate and percent of rooting in each media or media mix at the end of fourteen days. Rank and record your observations in the above tables.
4. At the end of fourteen days or at the time all cuttings have completely rooted, remove all cuttings and pot up.

Questions

1. In which media or media mix did the cuttings root fastest? ____________ Slowest? ____________
2. In which media or media mix was root formation most highly developed? ____________ Least developed? ____________
3. What media or media mix is best for rooting terminal cuttings? ____________

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Effects of Rooting Compounds on Rooting

Purpose

To show how rooting of terminal cuttings is influenced by different concentrations of a rooting compound.

Materials

1. One flat
2. Vermiculite
3. Thirty terminal cuttings of chrysanthemums, philodendrons, geraniums, or carnations
4. Different concentrations of a rooting compound (Hormodin 1, 2, or 3 or Cutstart X, XX, or XXX)

Procedures

1. Thoroughly water the media 24 hours prior to the time the cuttings are to be stuck.
2. Ask your instructor to demonstrate the procedure for making terminal cuttings on one of the following plants: chrysanthemums, philodendrons, geraniums or carnations.
3. If Hormodin is being used, place concentrations of H_1, H_2 and H_3 powders on separate pieces of paper.
4. Select one of the above plants. Make 10 cuttings. Dip the bases of the cuttings in the H_1 powder. Tap the excess powder of the cuttings as too much may retard root formation.
5. Stick the 10 cuttings in the vermiculite mix.
6. Repeat the above procedures using H_2 and H_3 powders. You should end up with 10 cuttings of three different Hormodin concentrations.
7. If the cuttings are not under a mist, syringe at least once per hour for two days to give the plants a good start.
8. Label each set of cuttings. Include date, name of cutting, and Hormodin concentration.
9. During the second to the fourteenth day, watering methods will vary with weather conditions. During the summer the cuttings should be watered-in well and then misted periodically for several days after planting. This reduces wilting and allows the cuttings to start in growth more rapidly.

   When planted during the winter the cuttings should be spot-watered, definitely leaving dry areas between plants. This allows the soil to dry more rapidly and root growth will be faster.

Observations

1. Check for rate of rooting at the end of the first ten days by carefully removing one or two plants from the media. Calloused tissue and a small number of primary roots should have formed.
2. List the Hormodin concentration that influenced the best root formation.

Hormodin Concentration

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

3. Check again for the rate of rooting at the end of fourteen days. Again list the Hormodin concentration that influenced the best root formation.

14 Days

Hormodin Concentration

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

4. At the end of fourteen days or at the time most cuttings have completely rooted, remove the cuttings and pot up. Record the percent of cuttings that rooted in each Hormodin concentration.

Percent Cuttings

Hormodin Concentrations				
H_1	______%	______%	______%	______%
H_2	______%	______%	______%	______%
H_3	______%	______%	______%	______%

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Effect of Lack of Nutrients on Plant Growth

Purpose

To show the effect nutrient deficiencies have on plant growth.

Materials

1. Deficient and sufficient plant growth sets 210A 1710 from: General Biological Supply House Incorporated, 8200 South Hoyne Avenue, Chicago, Illinois 60620.

   Solutions made from these sets can be used in plant experiments to demonstrate the effects from the lack of one important element. The chemicals in each set will make up nine quarts of growing solution. A direction sheet accompanies each set.

   The materials consist of eight sets; a sufficient or control set and sets deficient in calcium, iron, potassium, magnesium, nitrogen, phosphorus and sulfur.
2. A nutrient free or sterile growing medium. Examples are sterile cinders, silica, white salt sand or salt-free pure quartz sand washed in distilled water. Vermiculite can also be used.
3. Five to ten gallons of distilled water. (Amount depends on size of containers, number of plants used, and amount of sand to be washed. Distilled water should also be used to water the experimental plants in addition to the nutrient deficient solutions.)
4. Sixteen containers in which to grow the experimental and control plants. Examples include new unglazed flower pots or glass or crockery vessels which permit bottom drainage.
5. Sixteen healthy young monocotyledonous plants and sixteen healthy young dicotyledonous plants. All plants should be uniform in size. Corn is a good monocotyledonous plant and petunias, snapdragons, begonias or tomatoes are good dicotyledonous plants to use.

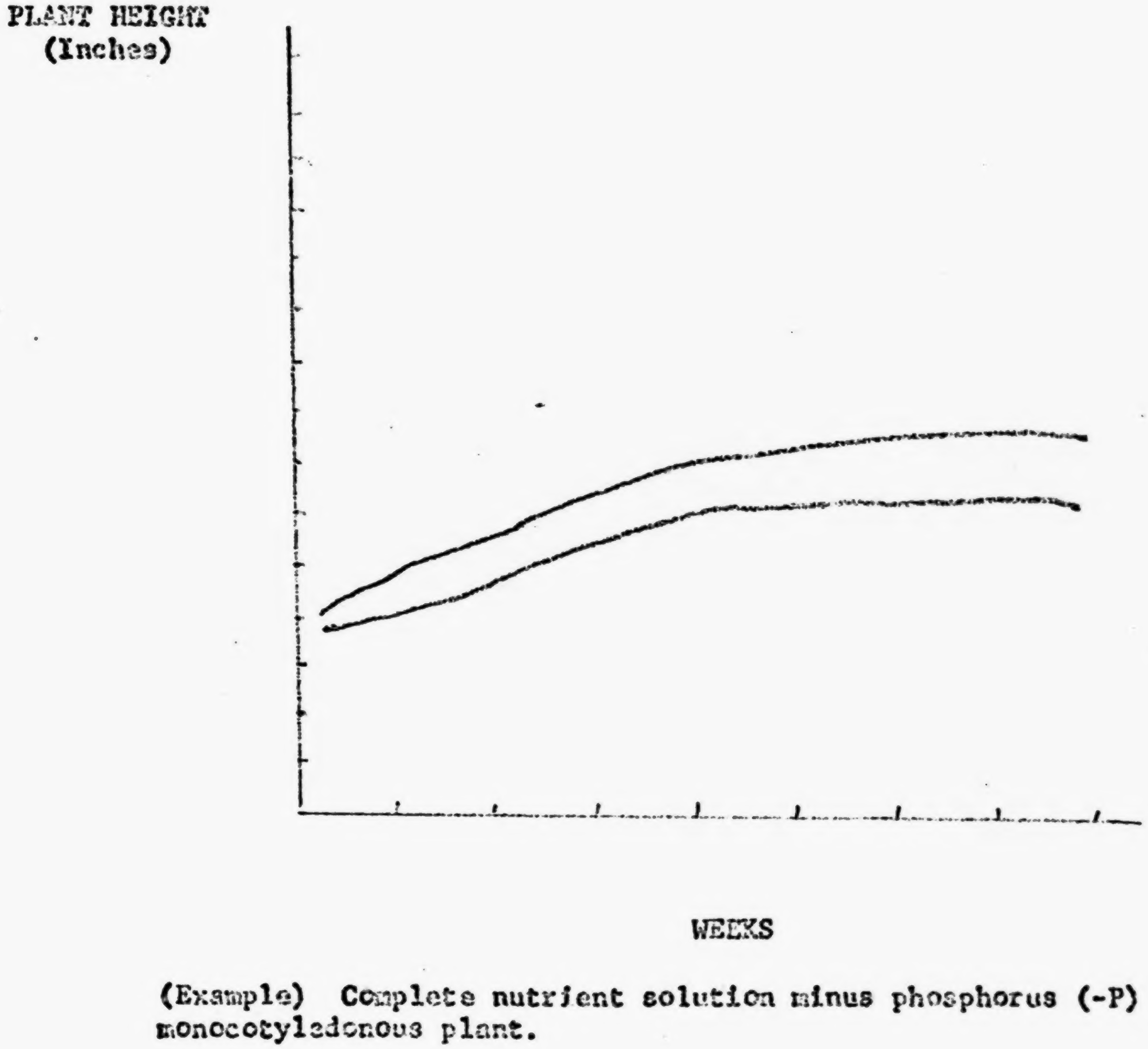
Procedures

1. Select sixteen containers. Wash with distilled water to remove all nutrients if the containers are not new.
2. A nutrient free growing medium is needed. If sand or silica is used, no washing is needed.
3. Place the nutrient free growing medium in the sterile containers.
4. Carefully transplant two monocotyledonous plants in each of the eight containers. Plant two dicotyledonous plants in each of the remaining eight containers. The roots of the plants should be washed in water to remove all medium or soil and then be washed with distilled water to avoid the presence of any nutrients.

5. Label each pot. Included should be date of transplanting, dicotyledonous or monocotyledonous, and the nutrient solutions to be added: Complete, -Ca, -Fe, -K, -Mg, -N, -P, and -S.
6. Mix nutrient solutions as directed with distilled water. Make sure the nutrient solution containers are properly labeled.
7. Apply the nutrient solutions immediately after transplanting and thereafter as needed, usually every second or third day. (Make sure nutrient solutions are applied to correspondingly labeled containers). At intervals between application of the nutrient solution, the plants should be watered with distilled water.
8. Maintain the plants in a uniform environment.

Observations

1. After transplanting and applying the nutrient solutions, measure the height of the plants in each container and record.
2. Measure and record the height of plants at intervals of one week for a period of four to six weeks. Growth curves can be set up for plants in each container as follows:



(Example) Complete nutrient solution minus phosphorus (-P) on monocotyledonous plant.

3. At the end of the two weeks and at the end of four weeks list the observed deficiency symptoms of each container.
4. Compare the observed deficiency symptoms on monocotyledonous and dicotyledonous plants for each nutrient deficient solution.

Questions

1. Did any of the plants growing in nutrient deficient solutions exhibit as much growth as did the complete nutrient solution? ____________ If so, which one (s)? ____________________
   Which plants most closely approached the height of the plants growing in the complete solution? ____________________
2. Were any of the plants dead after six weeks? ____________
   If so, which ones? ____________________
3. Which plants, monocotyledonous or dicotyledonous, exhibited deficiency symptoms the best? ____________________
   ____
4. List the functions of each of the following in plant growth: calcium, iron, potassium, magnesium, nitrogen, phosphorus and sulfur.

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Effects of Different Watering Intervals on Plants Growing in Different Media

Purpose

To show how different watering intervals affect plants growing in different media.

Materials

1. Fifteen clay pots
2. Fifteen geranium plants
3. One pan three to four inches deep which is large enough to hold three pots
4. Three types of media
   a. Sand
   b. Sand and perlite mixture
   c. Peat moss and vermiculite mixture

Procedures

1. Select fifteen geranium plants. Replant five geranium plants in each of the three media listed above.
2. Label each pot. Include name of plant, type of media, date of transplanting, and interval of watering.
3. Fill the pan three inches deep with water. Place geranium plants growing in each type of media in the pan. This will provide a medium that is saturated 100 percent of the time.
4. Place plants in the order suggested below and follow the watering schedule. When water is applied, give enough to saturate the whole mass of soil thoroughly. Maintain at a 70° F. temperature.

Watering Schedule

		Media	
Frequency	Sand	Sand and peat	Peat and Vermiculite
Saturated 100% of the time	○	○	○
		Pan filled with 3" of water	
Three times per day	○	○	○
Once per day	○	○	○
Once every two days	○	○	○
Once every four days	○	○	○

5. Follow the watering schedule listed above for a period of three to four weeks. The media saturated 100 percent of the time can be maintained by keeping the pan filled to a three-inch level with water.

Questions

1. Which watering interval resulted in the optimum growth of geraniums? ____________________
2. Which type of media provided optimum geranium growth? ____________________
3. Which medium provided the best drainage? ____________________
4. Which medium provided the best aeration? ____________________
5. Which medium provided the best water-holding capacity? ____________________
6. What five combinations of media and watering intervals resulted in the most desired growth of geraniums?
   a. ____________________
   b. ____________________
   c. ____________________
   d. ____________________
   e. ____________________
7. What happened to the plants that were saturated 100 percent of the time? ____________________

   Why? ____________________
8. Of the plants watered every fourth day, which media was the most susceptible to drought? ____________________

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Rate of Transpiration

Purpose

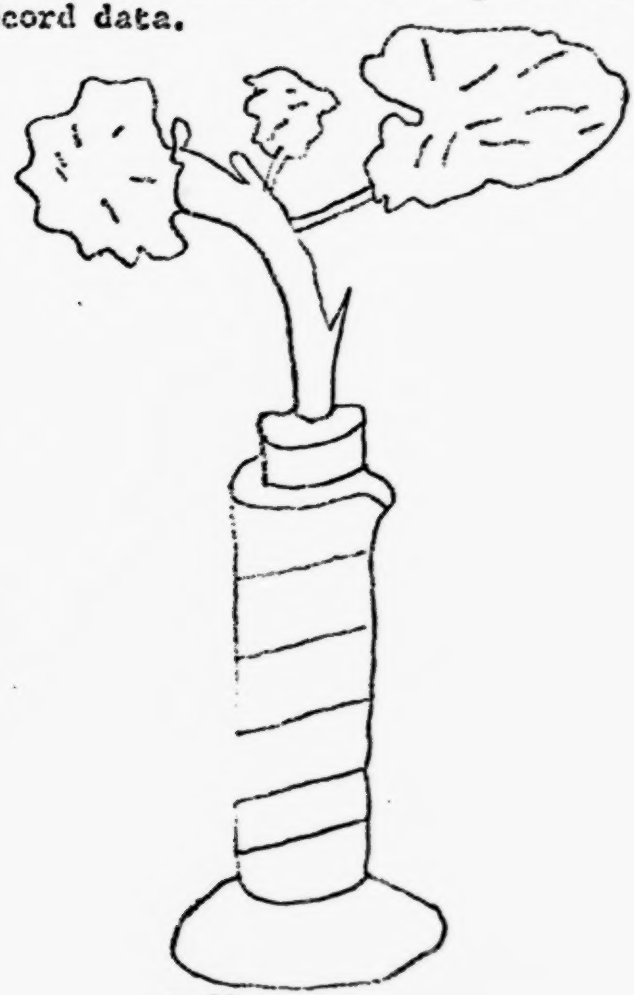
To demonstrate how the leaf area of a plant affects the rate of transpiration.

Materials

1. 4 graduated cylinders
2. 4 corks or stoppers
3. 4 geranium cuttings (1 with one leaf, one with two leaves, one with three leaves, and one with four or more leaves
4. water

Procedures

1. Make a hole in each cork or stopper to fit the stem of a geranium cutting.
2. It is important to have the hole in cork and the geranium stem the same size so that the amount of evaporation around it is negligible.
3. Push the cuttings through the hole in the stopper and cut off the end of plant under water to prevent air pockets. (See Figure 1)
4. Immediately insert corks into the graduated cylinders with the stem well below the waterline. (Push the stem of the plant nearly to the bottom of the cylinder.)
5. Record the water level.
6. Keep a record of the water level over a period of several days or weeks and record data.



Questions

1. Which plant used the most water? ______________________________
2. How did the amount of leaf area affect transpiration? ________
   ____
3. What is meant by "Rate of Transpiration?" ____________________
   ____
   ____
   ____

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Overgrowth Induced by Application of Chemicals

Purpose

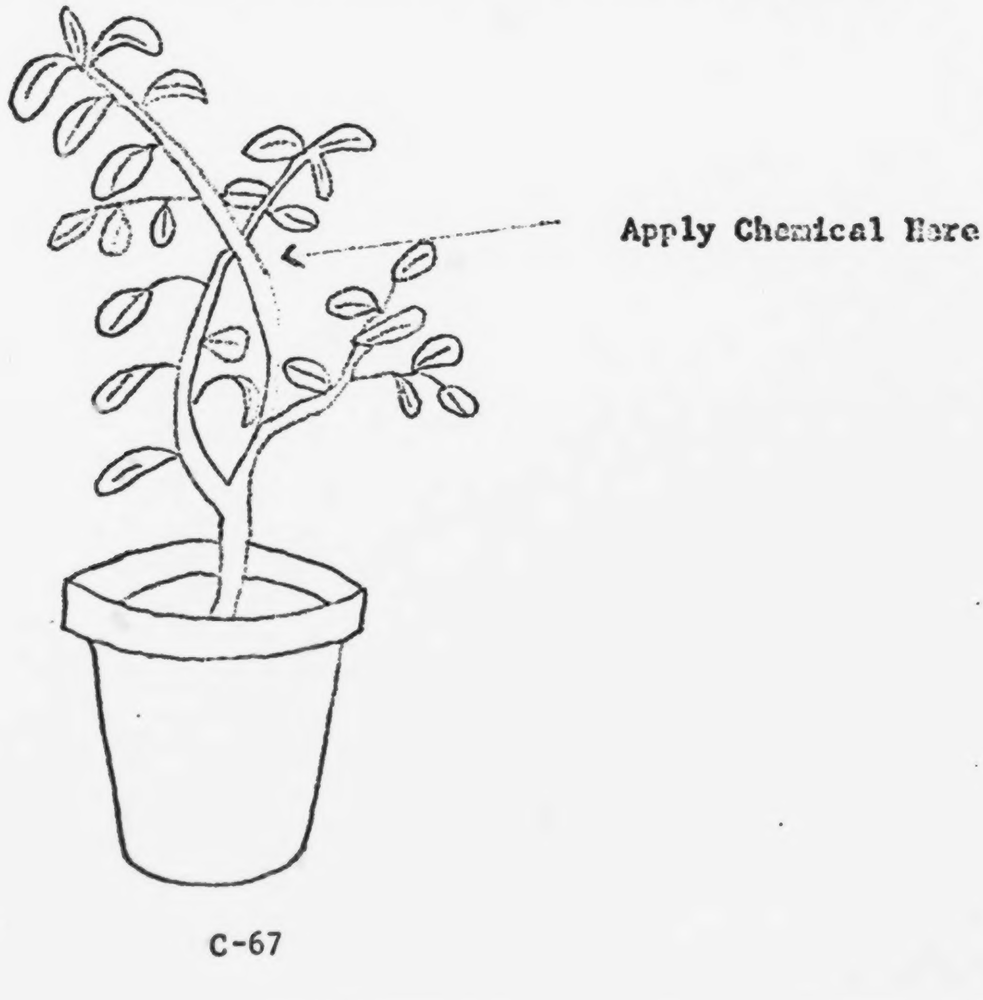
To show the effect of selective weed killers on plant growth.

Materials

1. Selective weed killers such as 2,4-D, MCPA, Silvex or 2,4,5-T.
2. One glass rod
3. Four flower pots (regular)
4. Four broad-leaved plants such as a potted geranium or begonia plant
5. Soil

Procedures

1. Secure four broad-leaved plants and set in pots.
2. Pack plants firm with soil.
3. Water plants as often as needed in order to keep the soil moistened.
4. Allow the plants to establish roots.
5. After the plants have established good root attachment, select an available weed killer from a garden or feed store.
6. With a glass rod, apply a drop of the selective weed killer to one side of the stem of the broad-leaved plant.
7. Try different concentrations of the chemical on three other broad-leaved plants.
8. Apply two drops of the selective weed killer to the second pot; three drops to the third pot and four drops to the fourth pot.



Observation

Within a few hours the cells on the treated side of the stem will cause the stem to bend in different directions.

Questions

1. Why did the cells on the treated side of the stem bend in different directions? ______________________________
____
____
2. Why was an overgrowth of the plants induced by the chemicals?
____
3. What were the effects of different concentrations of the same chemical on different broad-leaved plants? ______________________________
____
____
4. Why were broad-leaved plants used? ______________________________
____
5. What is a cell? ______________________________
____
6. What is a cell division? ______________________________
____
7. What is meant by "cell enlargement?" ______________________________
____

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Effects of Growth Regulators on Plants

Purposes

To show the effects that growth regulators have on plants.

To show how different growth regulators will extend the length of internodes, act as growth retardants, and increase the life of buds.

Materials

1. Concentrations of 5, 10, 100, and 1,000 parts per million of gibberellic acid to use on coleus, chrysanthemums, or geraniums. Ten of one kind of the above plants are needed.
2. Concentrations of 0.15 percent, 0.25 percent, and 0.5 percent of B-Nine to use on coleus, chrysanthemums, petunias, poinsettas, or lilies. Eight of one kind of the above plants are needed.

Procedures

1. Buy or mix concentrations of 5, 10, 100, or 1,000 parts per million of gibberellic acid. Tap water may be used to mix the concentrations.
2. Select ten coleus plants. (Chrysanthemums or geraniums may be used as substitutes.)
3. Spray each concentration of gibberellic acid on the crown of the roots of two plants. Do not spray two plants. They will be maintained as control plants. Keep the control plants out of the area when spraying.
4. Label each pot. Include date of spraying and concentration of gibberellic acid used.
5. Observe at the end of 14-20 days to see the extent of elongation of the internodes.
6. Compare the life of buds on the plants.
7. Repeat the above procedures with concentrations of 0.15 percent, 0.25 percent, and 0.5 percent B-Nine. Also have two control plants. Plants that can be used include coleus, chrysanthemums, petunias, poinsettas, or lilies. Spray on the foliage of plants to the point of run off.
8. Check the degree of suppression that occurs with different concentrations of B-Nine.

Questions

1. Which concentration of gibberellic acid gave the greatest elongation of the internodes? ____________________
   The least? ____________________
   ____
2. Did the different concentrations of gibberellic acid affect the life of buds on the plants? ____________________
   If so, how? ____________________
   ____
3. What concentration of B-Nine gave the greatest suppression of plant height? ____________________ The least? ____________________

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Effects of Light and Darkness on Plants

Purpose

To show the effects of different periods of light and darkness on plants.

Materials

1. Eight geranium plants
2. A dark room
3. A system of continuous fluorscent light

Procedures

1. Place one geranium plant in continuous darkness and one geranium plant in continuous light for 96 hours.
2. Forty-eight hours later, place one more geranium plant in darkness and one in continuous light.
3. Twenty-four hours later, place one more geranium plant in darkness and one in continuous light.
4. Maintain two geranium plants in normal light and dark periods as control plants.
5. Remove all plants at the same time so they will have been exposed to the total darkness and continuous light for periods of 96, 48, and 24-hour periods.
6. Label the plants as to how long they have been exposed to the varying light and dark conditions.
7. Water as often as needed during the experiment.

Observations

1. Observe and compare the plant color, shape, and other observable characteristics when removed from the experimental environment. Describe below:
   - a. 96 hours of darkness ______________________________
     ____
   - b. 48 hours of darkness ______________________________
     ____
   - c. 24 hours of darkness ______________________________
     ____
   - d. Control plants (alternate light and dark) ____________
     ____
   - e. 24 hours continuous light __________________________
     ____
   - f. 48 hours continuous light __________________________
     ____
   - g. 96 hours continuous light __________________________
     ____
2. Maintain the plants and observe after one week.
   - a. Did any plants seem to be adversely affected by exposure to the experimental light and dark periods? If so, how? _____
     ____

b. Which plants seemed to show no adverse affects? (Compare with the check plants.) ____

____

c. Would the results be the same for other plants? ____________

____

d. Do plants need alternating light and dark periods? ____________

____

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Effect of Oversterilization of Soil on Plant Growth

Purpose

To show the effects of excessive sterilization on plant growth and development.

Materials

1. Soil mixture sufficient to fill two small flats
2. Two small flats
3. Thirty rooted geraniums
4. Oven
5. Thermometer

Procedures

1. Fill the two flats with the soil mixture.
2. Place flat number one in the oven and oversterilize the soil by baking the soil for one hour at 300° F.
3. Place flat number two in the oven and sterilize it for the correct amount of time by maintaining the soil temperature at 180° F. for 30 minutes.
4. The next day plant 15 cuttings in flat number one and 15 cuttings in flat number two.
5. Observe the plants each day for 30 days.

Questions

1. What effect did the soil that was oversterilized have on plant growth? ______________________________
____
____
2. Why was there a difference in plant growth? ____________
____
____
3. What could be done to counteract the effects of oversterilization?
____
____
____
4. How long did it take for the effects of oversterilization to appear in the plants? ____________________
____
____

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Effect of Different Light Colors on Phototropism

Purpose

To show the effects of different light colors on phototropism.

Materials

1. Two potted plants or seedlings
2. Two boxes--2' x 3'
3. Two lamps fixtures
4. Two colored light bulbs
5. Small can of black paint and paint brush

Procedures

1. Secure two--2' x 3'--wooden boxes and paint the inside black.
2. Bore a hole large enough to insert the light fixture in each box and bore one hole one inch in diameter in the top and bottom of each box above and under the lights.
3. Attach a light fixture to the end of each box as shown in Diagram I.
4. Attach a cover to the front of each box to keep out light.
5. Place lamps with different colored bulbs in receptacle. Use 100 watt bulbs.
6. Illuminate the plants during daylight hours.
7. Allow one plant to grow in daylight as a control specimen.

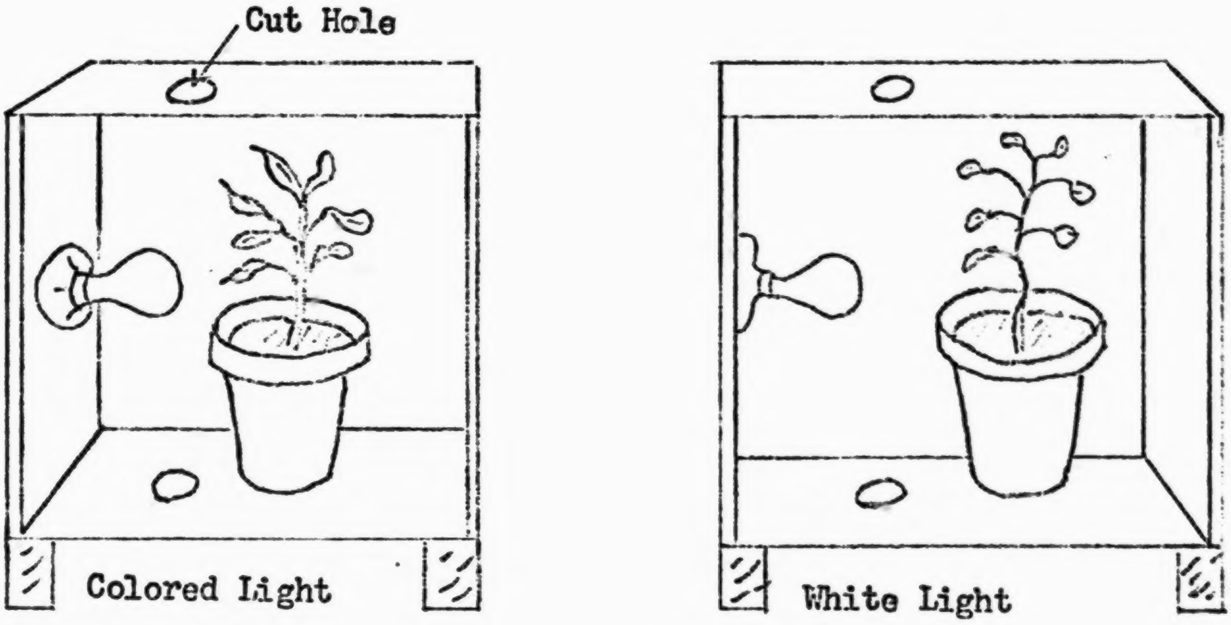


Diagram I

Questions

1. Why were the inside surfaces of the boxes painted black? ______

2. What are the effects of lengthening or shortening the period of illumination on the rate of growth, the character of growth, and blooming? ______

3. Why were the fronts of the boxes covered? ______

4. Why were holes put above and below the lights in each box? ______

5. List some light-absorbing materials ______

6. What is meant by "phototropism?" ______

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Effects of Light on Photosynthesis

Purpose

To show the effect that light has on photosynthesis.

Materials

1. Any plant that has a large green leaf, such as a coleus or philodendron
2. Six corks (Corks may be sliced into ½" pieces and pieces used in place of whole corks.)
3. Three straight pins

Procedures

1. Select one of the above plants and place one cork on the top of a large green leaf.
2. Place another cork directly beneath the top cork on the underside of the leaf.
3. Insert a straight pin through both corks and the leaf. This will eliminate light from an area of the leaf.
4. Repeat the above procedures on two other leaves of the plant.
5. Remove one pair of corks at the end of 24 hours, another pair at the end of 48 hours, and the last pair at the end of 72 hours.
6. After removal of the corks, observe the plants for three days.

Observations

1. At the time the corks are removed, describe the color of the spots under the corks removed at the end of:
   a. 24 hours ______________________________
   b. 48 hours ______________________________
   c. 72 hours ______________________________
2. After three days, did spots on any of the plants turn green?
   If so, which ones? ______________________________
   If not, why not? ______________________________

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Effects of pH Levels on Plant Growth

Purpose

To observe the effects of different pH levels on the growth of plants.

Materials

1. Twelve young growing, potted plants. Choose from the varieties listed below:
    a. Four azaleas or philodendrons
    b. Four asters, lilies or hydrangeas
    c. Four chrysanthemums or snapdragons

2. Solutions having the following pH readings to be used for watering the potted plants:
    a. Basic Solution (pH of 8.0 or above)
    b. Neutral Solution (pH of 7.0. Use available tap water.)
    c. Moderately acid (pH of 5.5)
    d. Very acid (pH of 4.0)

3. A pH indicator
4. Markers to identify the plants and the pH of solutions applied
5. Containers for the solutions. Label each container.
6. A chart to record observations at periodic intervals

Procedures

1. Select four each of the three types of potted plants listed in the "Materials" section. Select young growing plants that are approximately the same size.
2. Identify the plants and the pH solutions they are to receive by labeling the markers appropriately.
3. Prepare the alkaline solution by adding dilute sodium hydroxide (Na OH) to tap water to raise the pH to 8.0
4. Prepare the moderately acid solution by adding dilute sulfuric acid (H_2SO_4) to tap water to lower the pH to 5.5.
5. Prepare the very acid solution by adding dilute sulfuric acid (H_2SO_4) to tap water until the pH is lowered to 4.0.
6. Check the pH of the solutions with a pH indicator.
7. Water one of each type of plant with each pH solution as needed.
8. Check the plants periodically and record observations on a prepared chart.

Observations and Suggestions

1. Notice the differences in growth of the three different plants watered by the four pH solutions. Find the best pH in which to grow the particular plant.

2. Premixed chemicals may be obtained from mail order houses, garden supply stores or reputable fertilizer suppliers.

Questions

1. What is meant by the pH of a solution? ______________________________

____

____

2. How does the pH of the soil affect plant growth and nutrient uptake? ______________________________

____

____

Is this the same for all kinds of plants? ______________________________

____

____

3. The pH scale runs from __________ to __________. Any solution having a pH below 7.0 on the pH scale is ____________ and solutions above 7.0 are ____________ or ____________.

4. What can be used to determine the pH of a solution? ______________________________

____

5. Which plants in the above experiment grew best after being watered with a solution having a pH of 8.0? ______________________________

____

6. Which plants thrived after being watered with a solution having a pH of 4.0? ______________________________

____

7. Which plants in the above experimental conditions were adversely affected by different nutrient solutions applied? ______________________________

____

8. What nutrient deficiency symptoms appeared in the experimental plants? ______________________________

____

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Effects of Pinching on Lateral Growth

Purpose

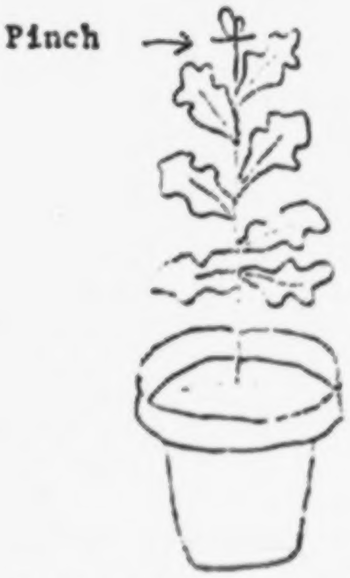
To show the effects of pinching on plants that exhibit apical dominance and plants that do not exhibit apical dominance. (Apical dominance refers to the effect of the apical bud in inhibiting the growth of dormant buds behind it.)

Materials

Six potted chrysanthemums and six potted coleus plants. All plants should be the same age and should be grown in the same medium.

Procedures

1. Select six chrysanthemums and six coleus plants of the same age.
2. Pinch off the terminal buds of three chrysanthemum plants and three coleus plants. Do not pinch the other six plants.
3. Provide all plants equal care and treatment during the experiment.
4. Observe the plants growth habits for six to eight weeks.



Questions

1. Coleus plants
   a. Did the coleus plants that received the pinch exhibit lateral growth? ________________________________
   b. Did the coleus plant that did not receive the pinch exhibit lateral growth? ____________________________
   c. Which plants produced lateral growth first? __________ Why?____
   ____
2. Chrysanthemum plants
   a. Did the chrysanthemum plants that received the pinch exhibit lateral growth? _______ Why? ____________________
   ____
   b. Did the chrysanthemum plants that were not pinched exhibit lateral growth? _______ Why? ____________________
   ____

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Effect of Oxygen Deficiency and Excess Oxygen on Germination of Seeds

Purpose

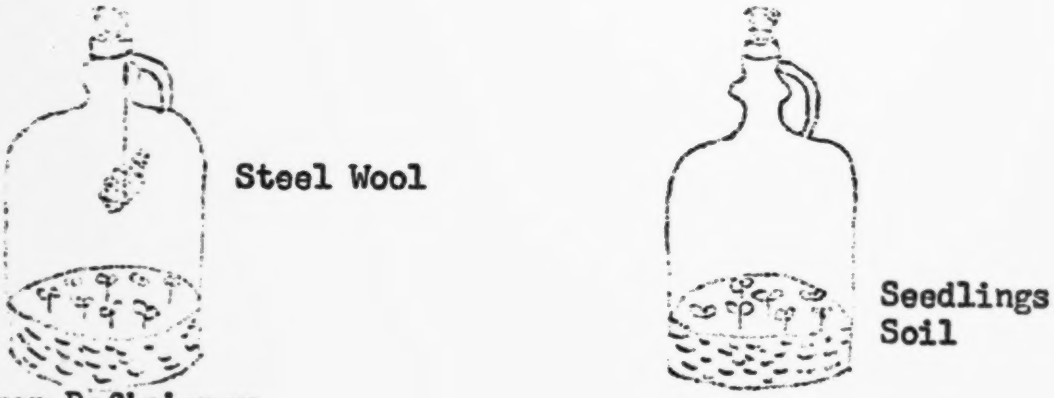
To show the effects of a lack of oxygen and excessive amounts of oxygen on seed germination.

Materials

1. Three one gallon jugs
2. Two rubber stoppers, one two-hole rubber stopper
3. Fast growing seeds such as radish or squash seeds
4. A strip of steel wool and a string
5. Two pieces of glass tubing bent at right angles
6. Two pieces of rubber tubing and two clamps
7. A quantity of soil

Procedures

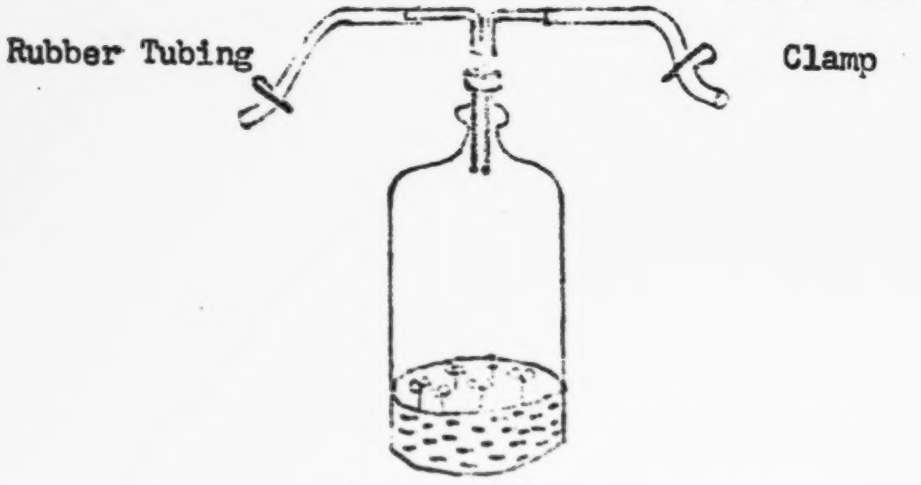
1. Fill two one gallon glass jugs with moist soil to a depth of three inches.
2. Drop in some fast growing seeds.
3. Add more moist soil to cover the seeds.
4. Unroll a strip of steel wool, moisten it throughly, and suspend it inside one of the jugs by means of a string. Close this experimental jug with a rubber stopper. Also close the control jug not having steel wool placed inside with a rubber stopper. Note: The moist steel wool should create an oxygen deficiency in the experimental jug.
5. Observe both jugs at regular intervals and make notes of any differences in the germination of the seeds.
6. Plant seeds in the third jug as described above.
7. Place a two hole stopper with the two right angle glass tubings inserted in the stopper into the jug. Caution: Thoroughly wet the glass tubings and rubber stopper before forcing the glass tubings into the rubber stopper.
8. Force oxygen into the jug. This can be done by forcing oxygen into one tube and letting the air escape from the other tube. The source of oxygen may be from the oxy-acetylene tanks found in most schools shops.
9. When an excess of oxygen has been forced into the jug, close the hoses on both ends with clamps.
10. Compare the germination of seeds in this jug with excess oxygen with the germination of seeds in the control jug and the jug having an oxygen deficiency over a period of two or three weeks. Record the results.


Steel Wool
Seedlings
Soil

Oxygen Deficiency
Experimental Jug

Control Jug

Figure 1


Glass Tube
Rubber Tubing
Clamp

Excess Oxygen
Experimental Jug

Figure 2

Questions

1. Why was the steel wool moistened? ____________________
____

2. What factor or factors indicate an oxygen deficiency in seed germination? ____________________
____
In plant growth? ____________________
____

3. What happened to the germinating seedlings which received an excess amount of oxygen after two weeks? ____________________
____
____
After three weeks? ____________________
____
____

4. What is respiration? ____________________
____

5. How does the moisture content of the air and the temperature level influence the rate of respiration and the longevity of seed in storage? ______

______

______

______

6. What are the principal environmental factors affecting seed germination? ______

______

7. What processes are taking place in seeds during germination?

______

______

8. What are the functions of water in germination? ______

______

______

9. What are the functions of oxygen in germination? ______

______

______

10. Does light stimulate the germination of seeds of some horticultural crops and reduce germination of others? ______
Why? ______

______

______

PLANT GROWTH AND DEVELOPMENT LABORATORY EXERCISE

Effect of a Deficiency and an Excessive Amount of Carbon Dioxide on Plant Growth

Purpose

To show the effects of a lack of and an excessive amount of CO_2 on plant growth.

Materials

1. Caustic soda or sodium hydroxide (This is the same compound commonly used to remove grease from drain pipes.)
2. Two one-gallon jugs
3. One small pill bottle or test tube
4. Small radish seedlings and soil
5. Cork or stopper
6. String

Procedures

1. Secure two one-gallon jugs.
2. Place soil and radish or squash seeds in jug. Insert cork or stopper.
3. Water as often as needed by the use of a pipette or water dropper.
4. Allow the seeds to grow for a couple of weeks.
5. Remove cork and transfer caustic soda or sodium hydroxide very carefully to a small pill bottle or test tube.
6. Suspend pill bottle or test tube with caustic soda or sodium hydroxide inside a glass jug containing small seedlings. This will absorb CO_2 and thus decrease the level of CO_2 in the jug. See Figure 1.
7. With the apparatus shown in Figure 2, blow your breath several times into a jug containing small radish seedlings. Repeat this every day for a week or two. Note: This should keep the concentration above normal.
8. Observe the difference in the growth of plants.

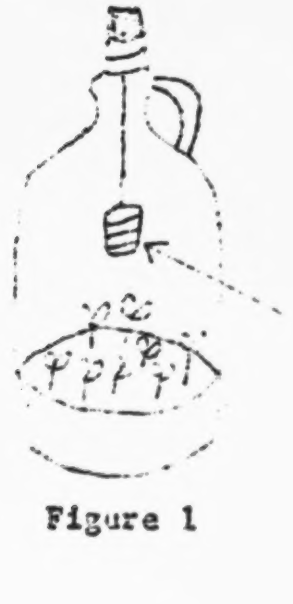


Figure 1

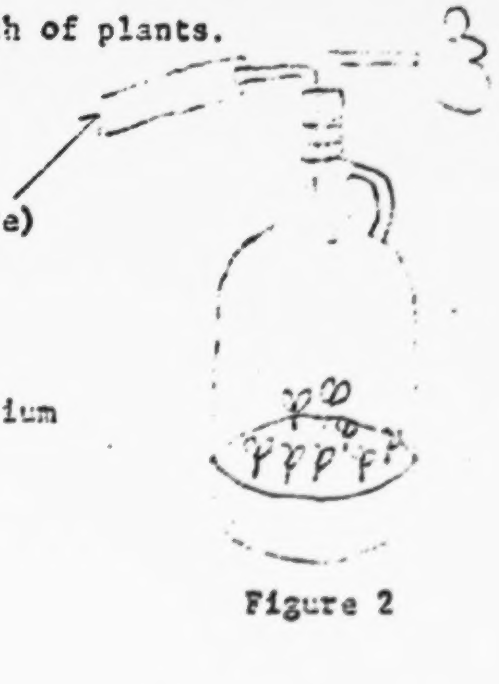


Figure 2

Questions

1. Why was the caustic soda, which was enclosed in pill bottle or test tube, suspended inside the glass jug? ______________________

    ____

2. Is the rate of growth of the seedlings affected by a deficiency of CO_2? ____

3. Is the rate of growth of the seedlings affected by an excessive amount of CO_2? ____

4. Why is it recommended in this experiment that one blow several times in the jug for an excessive amount of CO_2? What is another means of securing additional CO_2? ___________________________

    ____

5. Why is carbon dioxide important to plant growth? _____________

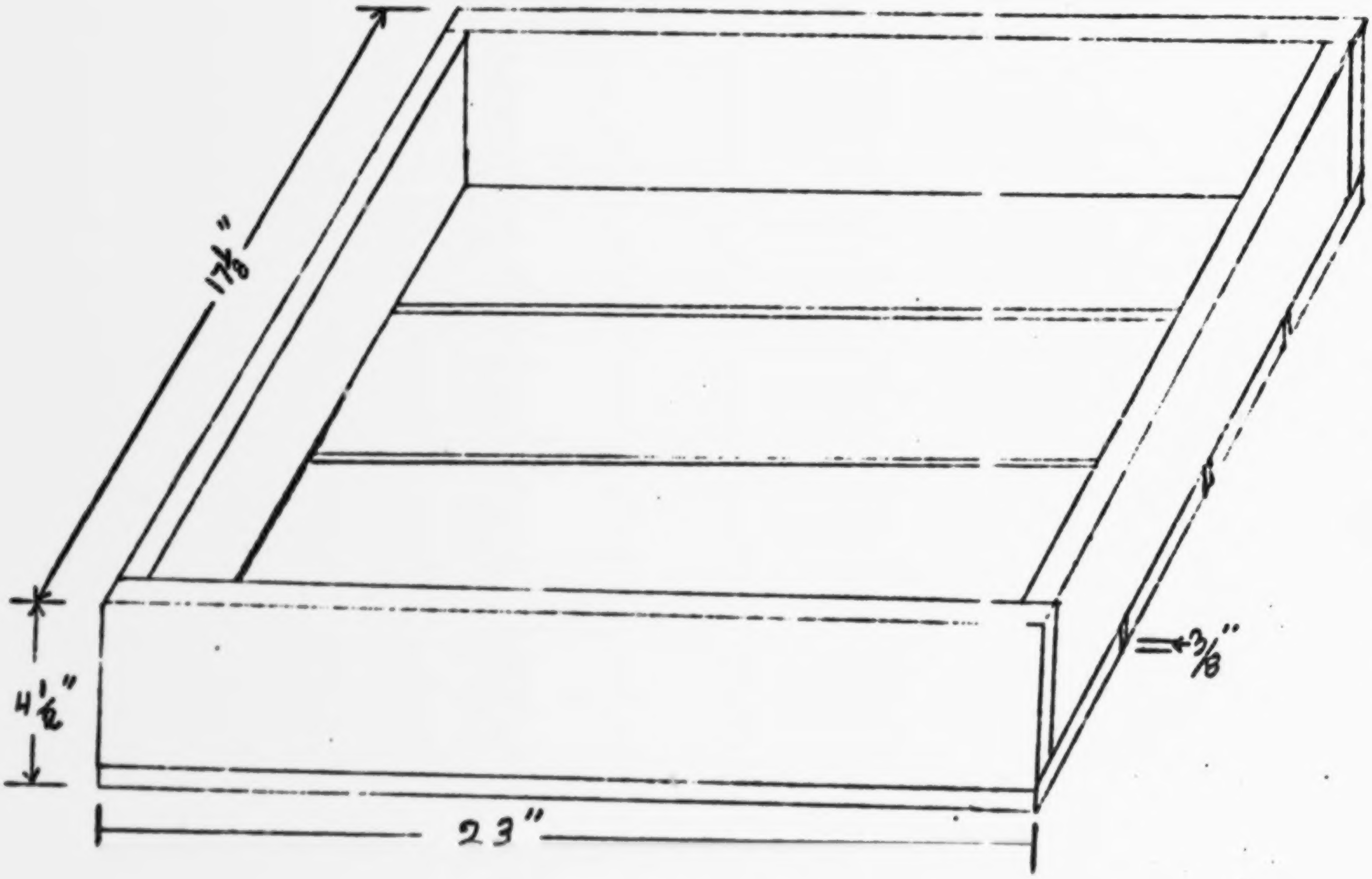
    ____

    ____

    ____

HORTICULTURAL MECHANICS PROJECT

Constructing a Flat



Bill of materials: (Use redwood stock)

Item	No. of pieces	Size
Ends	2	3/4" x 4" x 23"
Bottom	4	1/2" x 4" x 23"
Sides	2	1/2" x 4" x 15 5/8"
Nails	½ lb.	4d or 6d

HORTICULTURAL MECHANICS PROJECT

Constructing a Growing Bench

Introduction

The following dimensions may be altered to fit the space available. Additional bracing for the legs and a cover for the bench may be added to this plan.

A 2" x 2" frame that will exactly fit the bench and covered with polyethelene will suffice. One-half-inch drainage holes should be placed in an eight-inch pattern in the bottom of the box.

Bill of materials

Description	No. of pieces	Size
Sides of box	2	1 3/4" x 8" x 72"
Bottom of box	4	1 3/4" x 8" x 72"
Ends of box	2	1 3/4" x 8" x 26½"
Side supports	2	1 3/4" x 4" x 60"
End and middle supports	3	1 3/4" x 4" x 22½"
Legs	4	3 3/4" x 3 3/4" x 26½"
Corner braces	8	1½" x 6" flat metal
Carriage bolts	8	7/16" x 6"
Washers	8	7/16"
Flat wood screws	40	3½"

Procedures

1. Use two-inch finished or unfinished redwood lumber. (If unfinished lumber is used the dimensions of some pieces must be altered.)
2. Cut all lumber to desired dimensions.
3. Assemble the box with three and one-half-inch wood screws and corner braces.
4. Attach the side and end supports to the box.
5. Bolt the legs in place with the seven-sixteenth-inch bolts.
6. Drill drainage holes in the bottom on the box.

ORTHOGRAPHIC DRAWINGS

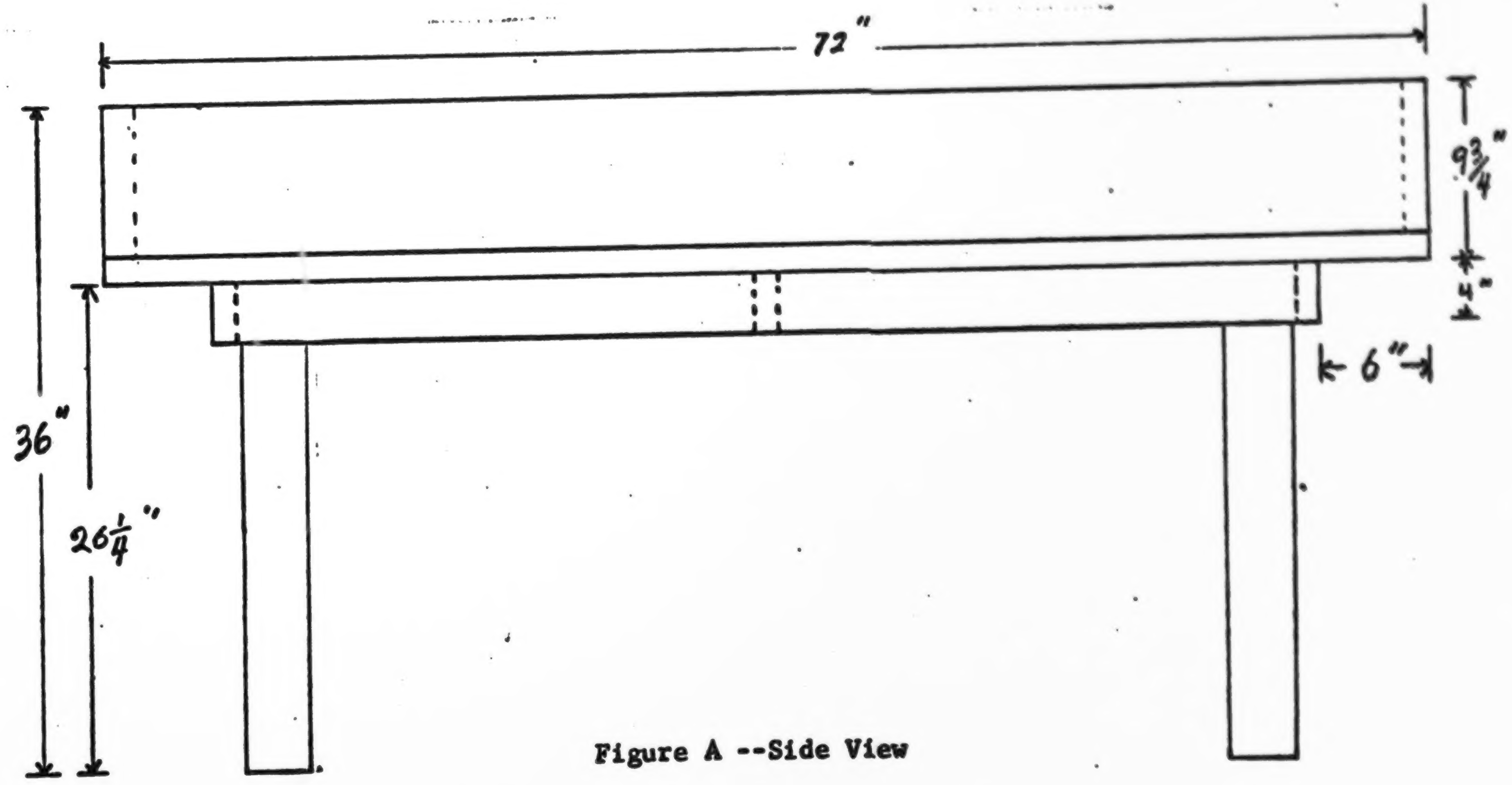

72"
9¾"
4"
36"
26¼"
6"

Figure A --Side View

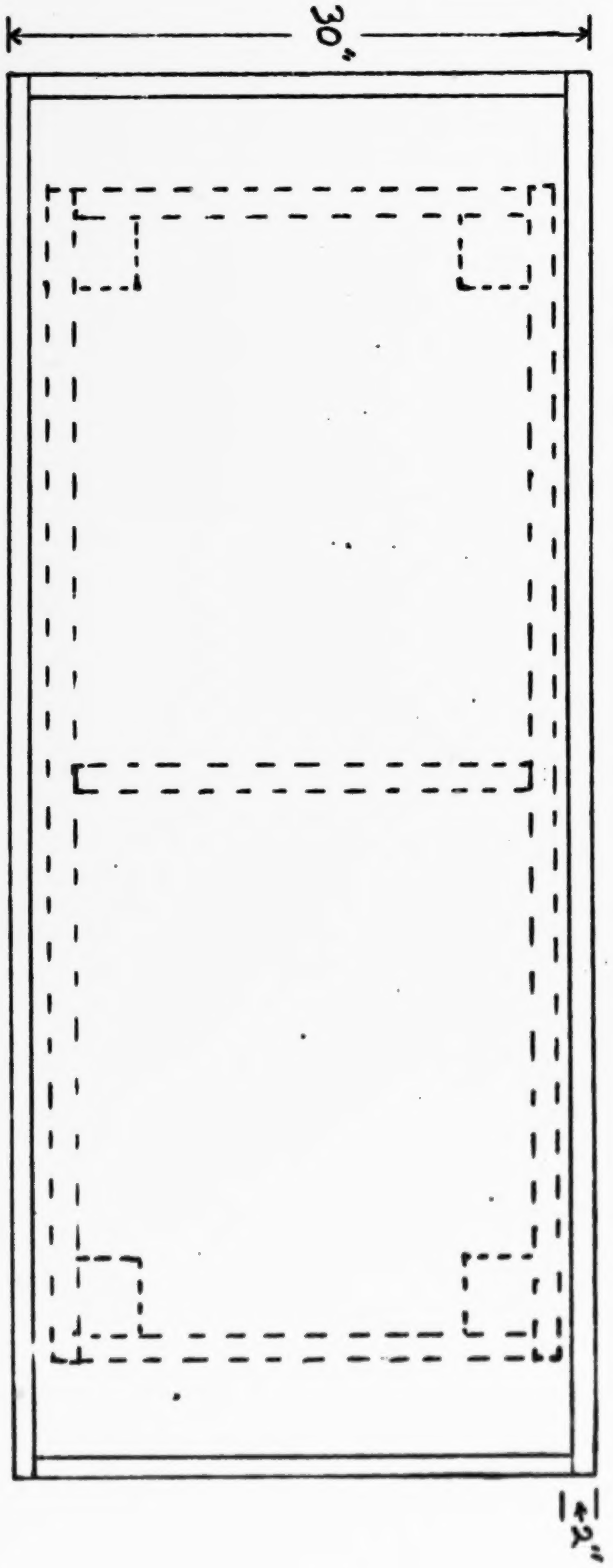


Figure B --Top View

HORTICULTURAL MECHANICS PROJECT

Constructing a Plant Grower

Introduction

The plant grower may be used for demonstration purposes to accelerate germination of seeds, produce stockier seedlings, stimulate the rooting of cuttings, and produce fibrous root systems.

Bill of materials

Description	No. of pieces	Size
Sides	2	3/4" x 18" x 36"
Bottom	1	3/4" x 18" x 50"
Top (front and back)	2	3/4" x 4" x 50"
Braces (top)	2	3/4" x 1½" x 16½"
Trim (bottom sides)	2	½" x 1½" x 18½"
Trim (bottom front)	1	½" x 1½" x 52½"
Shelf	1	3/4" x 17" x 49½"
Back (optional)	1	¼" x 36" x 51½"
Strips for adjustable shelves (metal)	4	½" x 24"
Radiant energy Fluorescent lamps 2-lamp strips	2	49" length
Assorted nails	¼ lb.	
Wood finish	½ pt.	

Procedures

1. Cut all pieces of wood to size.
2. Groove and install adjustable shelving strips in sides.
3. Assemble bottom, sides, and top.
4. Attach top cross braces.
5. Attach plywood back.
6. Attach trim to front and sides.
7. Sand and finish.
8. Attach lights.

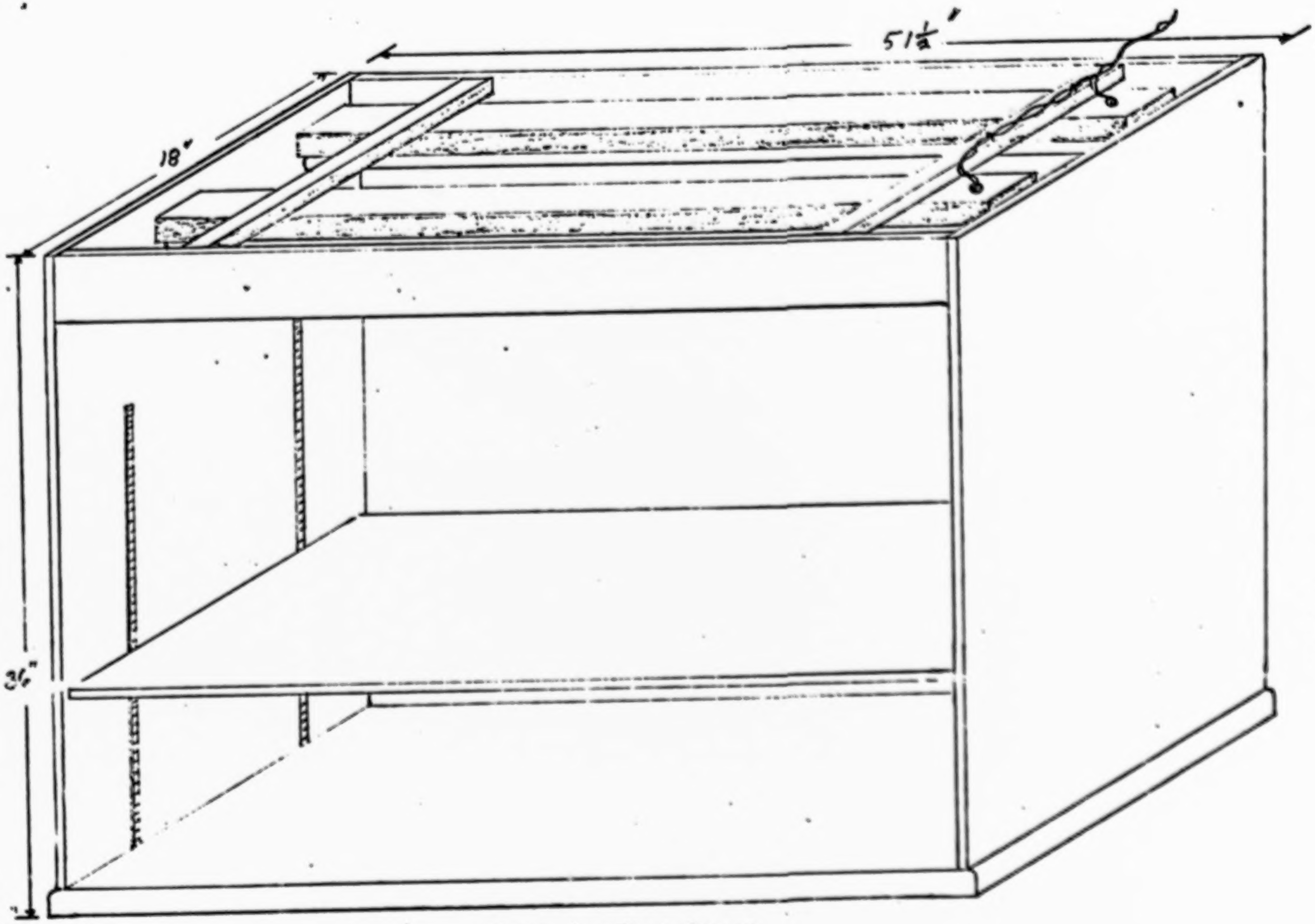


Figure A.--Plant Grower

HORTICULTURAL MECHANICS PROJECT

Constructing a Hotbed

Introduction

Hotbeds and coldframes are identical except that the hotbed has provision for heat. The basic measurement for a hotbed is a 3 x 6 foot sash. Multiples of this dimension may be placed side by side to give the desired growing area. The hotbeds should be placed in a sunny area with front (lowest end) toward the sunny side. Twelve inches of the box should be underground.

Bill of materials

1. 18 cubic feet of coarse sand
2. 21 cubic feet of fine sand
3. 60 feet of electrical cable with controls
4. 6 x 6 foot section of one-fourth-inch mesh "hardware cloth"
5. Materials for the frame

Description	No. of pieces	
Sides of box	2	3/4" x 24" end and 18" end x 70½"
Front of box	1	3/4" x 18" x 72"
Back of box	1	3/4" x 24" x 72"
Middle brace	1	3/4" x 2" x 70½"
Sash	2	3' x 6' standard sash with glass
Hinges, narrow cabinet	4	1"

Procedures

1. Build the frame to the desired dimensions. (Concrete blocks may be substituted for wood.)
2. Treat the wood with copper naphthalene wood preservative. (Do not use cresote since it gives off fumes which are poisonous to plants.)
3. Remove 12 inches of the top soil in the area the frame is to be located so the frame can be positioned with the lower 12 inches underground.
4. Position the frame and refill the area around the sides with soil.
5. Place the coarse sand in the lower six inches of the frame.
6. Install the heating cable beginning three inches from the side and placing the loops seven inches apart.
7. Place one inch of fine sand on top of the heating cable.
8. The one-fourth-inch mesh "hardware cloth" is installed next. (This protects the heating cable from digging tools.)
9. Place six inches of clean sand above the hardware cloth.
10. Fasten the sashes to the frame by attaching the hinges to the back of the frame and connect the controls to the heating cable.

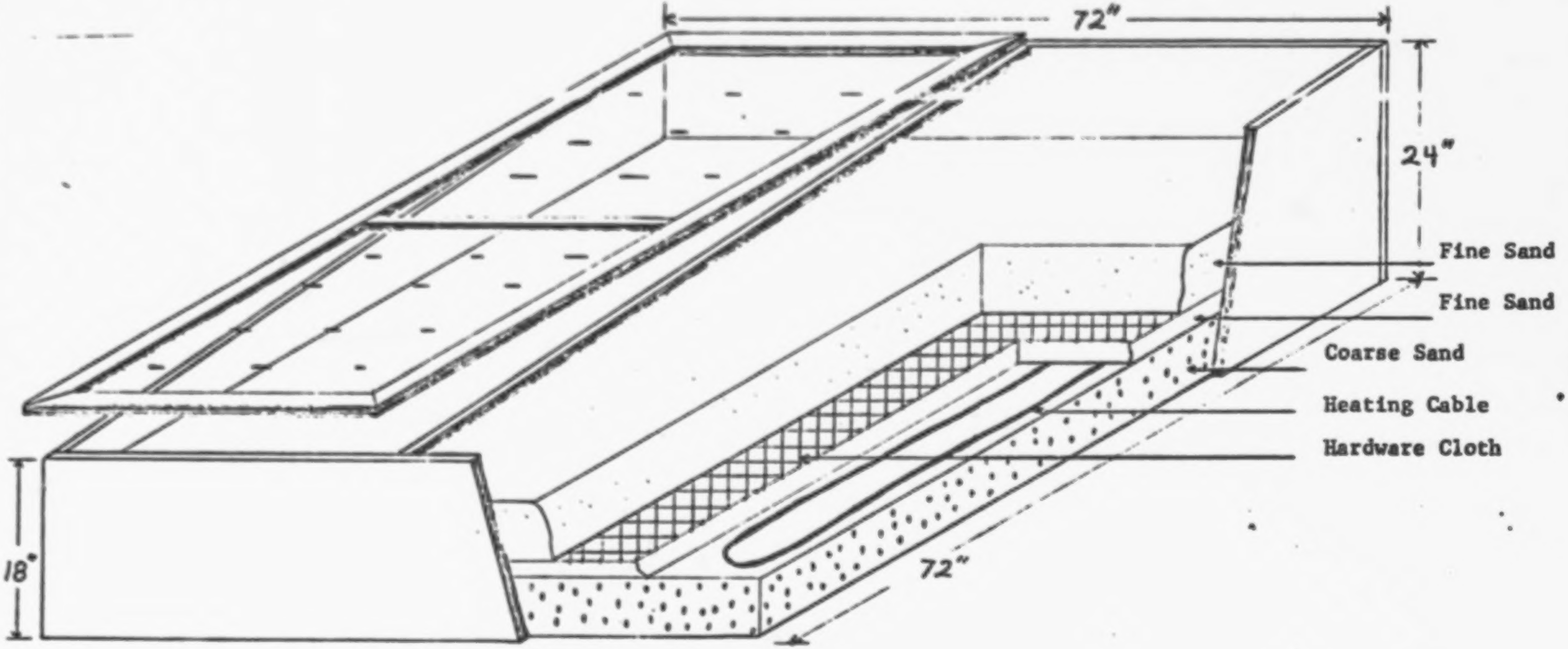

72"
24"
18"
72"
Fine Sand
Fine Sand
Coarse Sand
Heating Cable
Hardware Cloth

Figure 1--Diagram for a Hotbed

HORTICULTURAL MECHANICS PROJECT

Building a Portable Lath Screen

Introduction

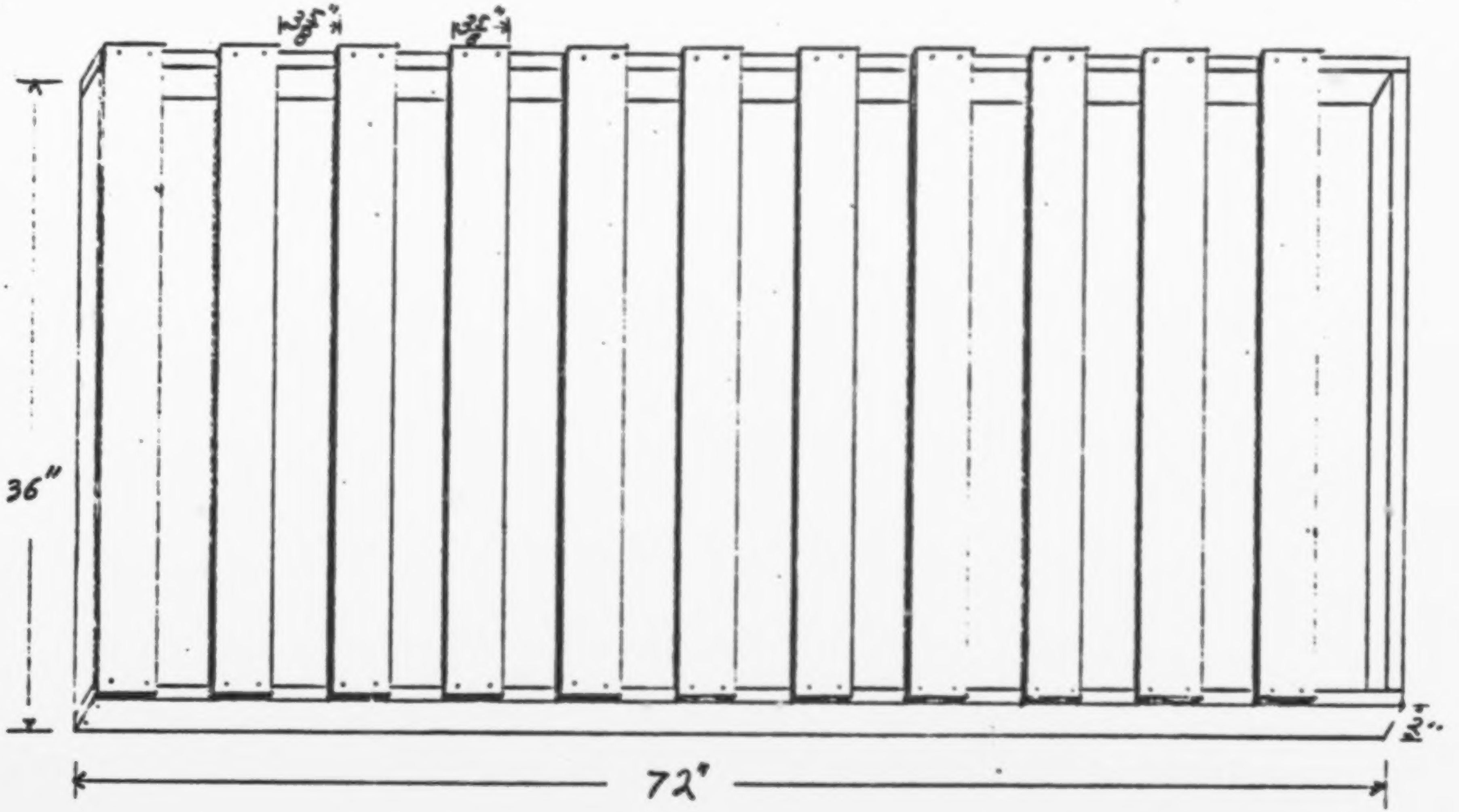
The portable lath screen may be made in various sizes but the common size is 3' x 6' so it will fit one section of the hotbed or coldframe. Plasterer's lath may be used but reduced lath or batten strips 3 5/8" wide are more suitable. The screen may be made to give 50 percent or 75 percent shade. For 50 percent shade make the spaces between strips as wide as the strips and 75 percent shade make the spaces one-half as wide as the strips.

Bill of materials

Description	No. of pieces	Size
Ends	2	3/4" x 2" x 34½"
Sides	2	3/4" x 2" x 72"
Strips	11	3/8" x 3 5/8" x 36"
Assorted nails		

Procedures

1. Cut all pieces of wood to the proper size.
2. Assemble the outside frame.
3. Nail the lath or batten across.


3 5/8"
2 5/8"
36"
72"
2"

Portable Lath Screen

HORTICULTURAL MECHANICS PROJECT

Constructing a Climatarium

Introduction

This climatarium was designed to be used either in the classroom or shop; therefore, the width must allow it to pass through doors. The lumber used should be Douglas fir or redwood which is pressure treated with copper napthenate. The covering may be one of many types but rigid fiberglass sheeting approximately 3/48" thick is recommended in this plan. The doors are made of fiberglass with a 3/4" x 2" frame around the fiberglass. The doors may be hinged, hooked in place, or made to slide as they have been designed in this plan.

The lights are adjustable in height through the use of chains and are switched so that the lights on each end and each level are controlled separately.

The floors are made of corrugated asbestos and are sloped with a 1" drop to one end for drainage purposes. The water drains off the floor into trays which are sloped to one side. The top drainage tray empties into the bottom tray which empties into a drainage pan on the floor. The drainage trays will most likely have to be custom made for this purpose. Care should be taken to insure that the floors properly drain into the trays without leakage.

The control panel and exhaust fans are situated on the opposite end of the drainage system. The controls should be placed in a box which can be closed. One exhaust fan is located on the top level and one on the bottom level. The exhaust fans are wired so they may be turned off and on manually or by the thermostat. The thermostat should be placed in the upper level toward the center of the chamber. The thermometer and humidity indicator should not be rigidly fastened so they may be used in both compartments.

Approximate Bill of Materials

Lumber. Douglas fir or redwood, pressure treated with cooper napthenate.	
2" x 4" S4S Stock, 120 board feet. 24 cents a foot.	$30.00
1" S4S Stock, 20 board feet, 30 cents a foot.	6.00
Corrugated asbestos sheets. Two pieces 10' x 42" at $15.00 a sheet.	30.00
Fiberglass. Flat sheets approximately 75 square feet at $ .35 a square foot.	26.00
Electrical system. Lights, eight two-lamp reflector units at $9.38 each.	75.00
Three cartons (six lamps per carton) of wide spectrum lamps at $11.28 per carton.	34.00
Cable, 50 feet of 14 ga., three conductor cable at $23.00 per 100 feet.	12.00
Time switch, single pole	9.00
Switches, six three-position toggle switches $1.50 each $9.00 One two-position toggle switch $2.00	11.00

Miscellaneous. Thermometer and humidity indicator.	$10.00
Thermostat, 120 volt, 2° switch differential.	17.00
Exhaust fans, two four-inch muffin fans at $5.00 each.	10.00
Casters, four H. D. lock type.	12.00
Nails, screws, chain (for lights) rubber hose (for drainage system).	10.00
Total Estimated Cost	$292.00

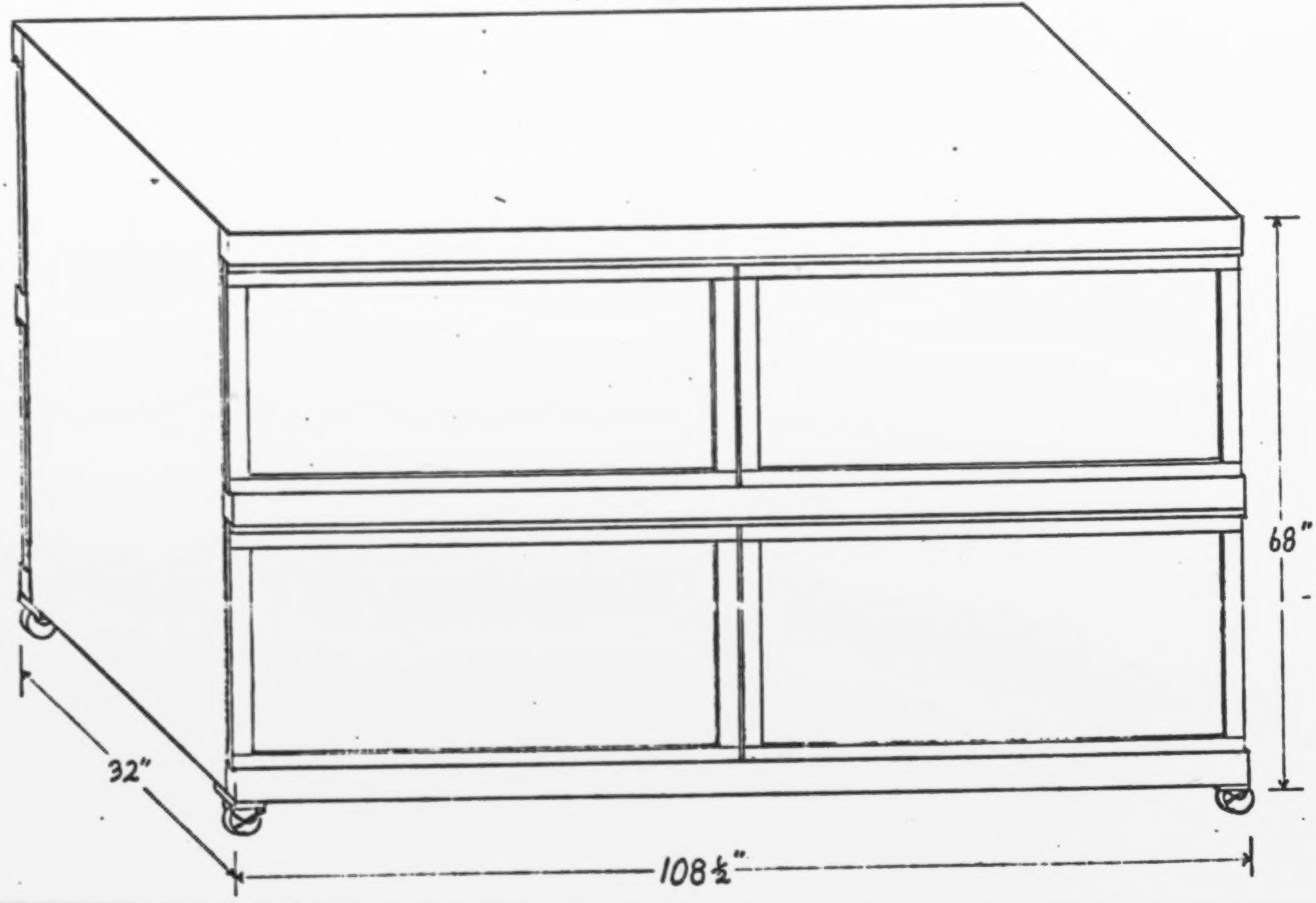
Procedures

The frame should be built first. In order to make the frame as strong as possible use lap and dado joints instead of butt joints wherever possible. The casters and hooks for the lights should be positioned before installing the corrugated asbestos. In fastening the asbestos, the screw holes should be drilled in the top of the corrugations, not in the bottom, because of leakage.

Next, construct the drainage trays and install them in place and attach the drainage hoses. The doors should be constructed next. Install the exhaust fans and control panels and wire the electrical system. The lights should be hung in place after the framework has been painted with a suitable paint (a paint designed for use with plants). Lastly the fiberglass covering should be placed on the ends and top.

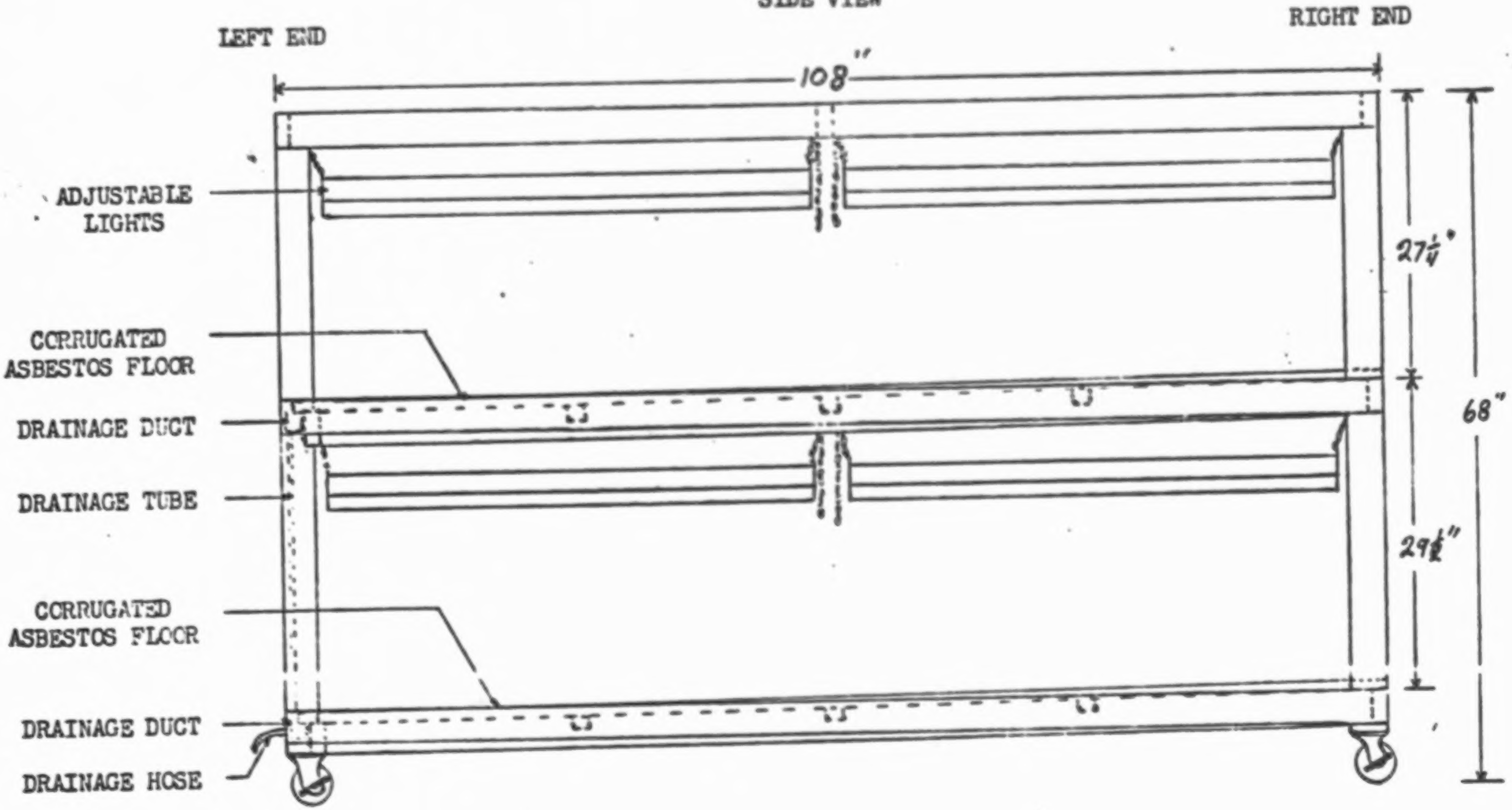
CLIMATARIUM

OBLIQUE DRAWING



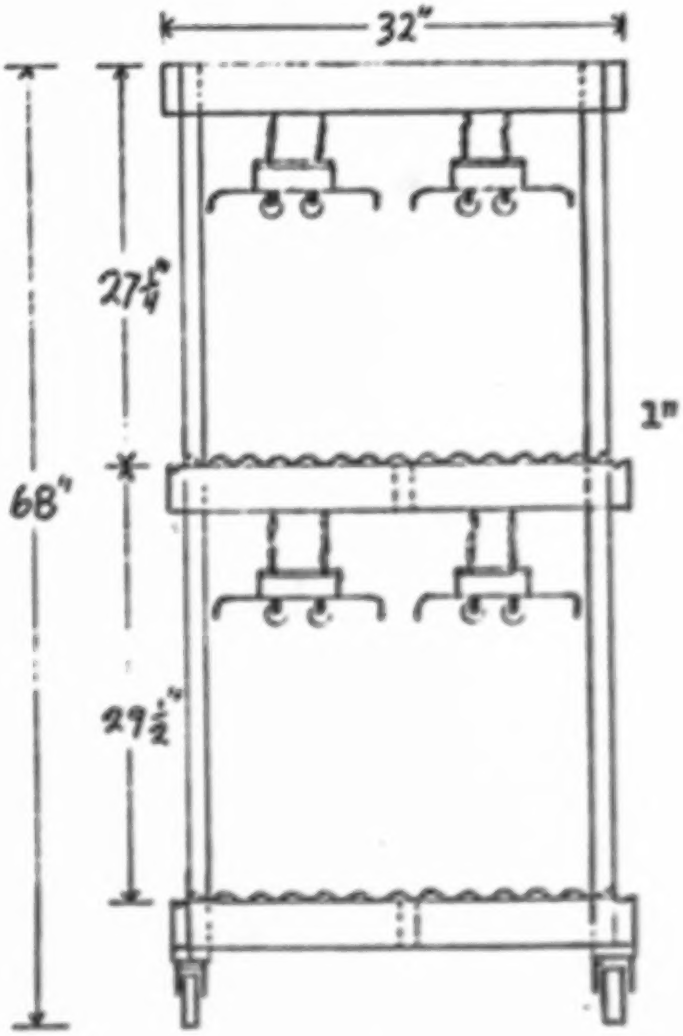
FRAME STRUCTURE

SIDE VIEW

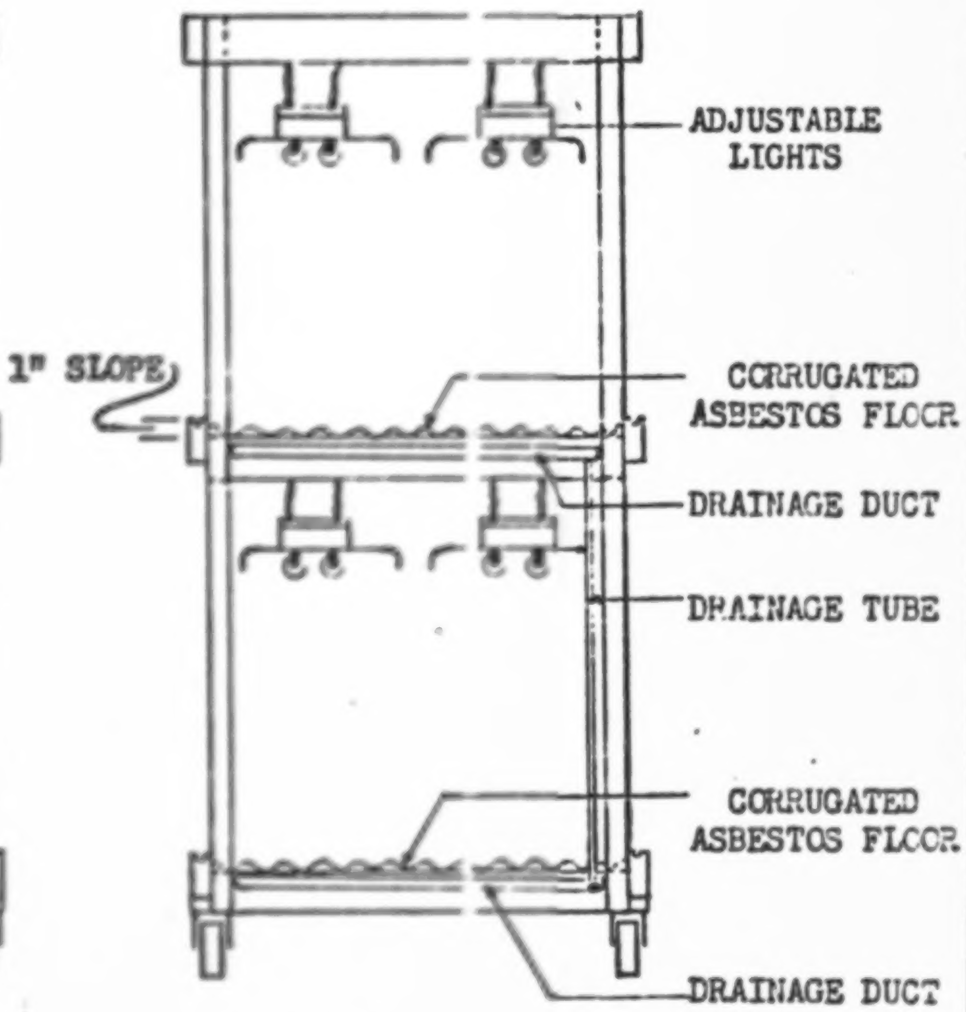

LEFT END
RIGHT END
108"
ADJUSTABLE LIGHTS
CORRUGATED ASBESTOS FLOOR
DRAINAGE DUCT
DRAINAGE TUBE
CORRUGATED ASBESTOS FLOOR
DRAINAGE DUCT
DRAINAGE HOSE
27¼"
29½"
68"

FRAME STRUCTURE

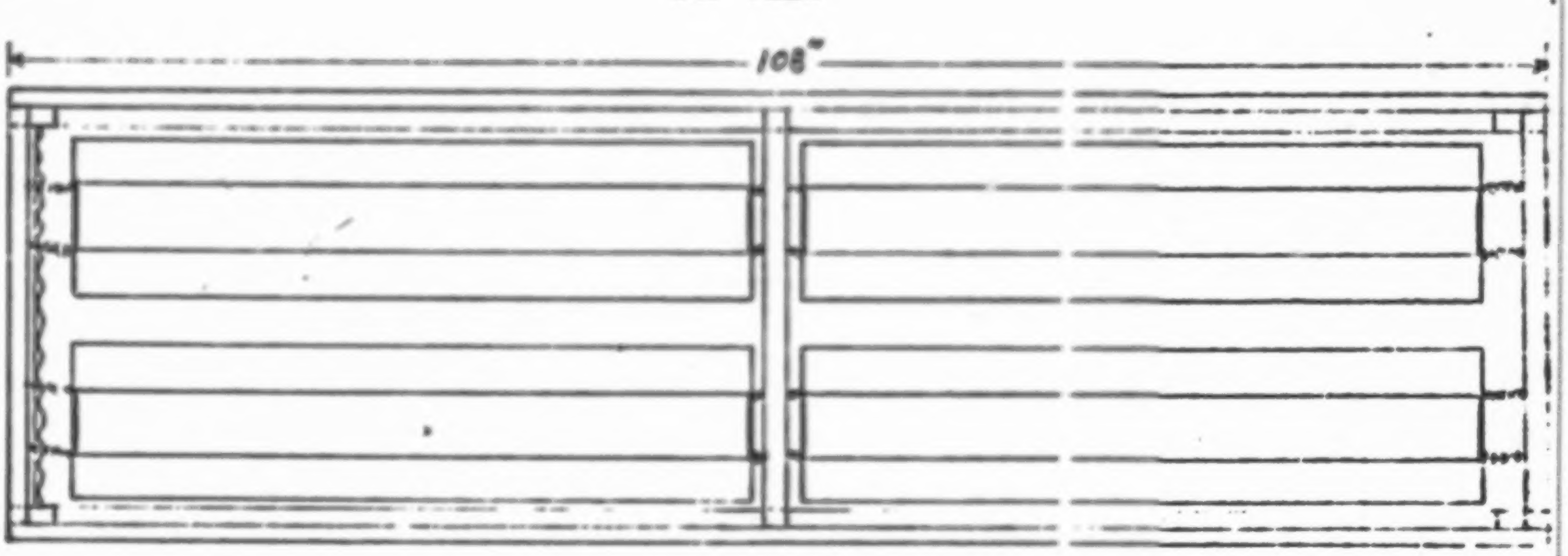
RIGHT END VIEW

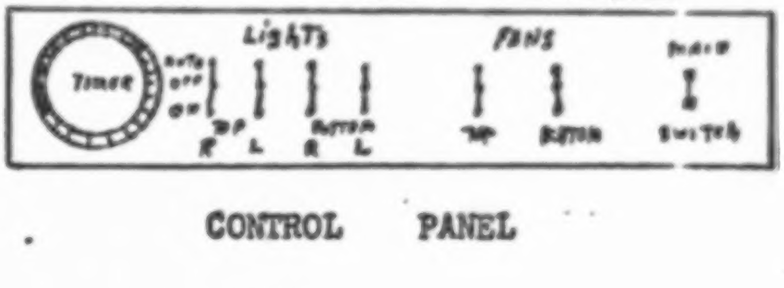

32"
27 1/4"
68"
29 1/2"

LEFT END VIEW


ADJUSTABLE LIGHTS
1" SLOPE
CORRUGATED ASBESTOS FLOOR
DRAINAGE DUCT
DRAINAGE TUBE
CORRUGATED ASBESTOS FLOOR
DRAINAGE DUCT

TOP VIEW




TIMER
AUTO
OFF
ON
LIGHTS
TOP
R
L
BOTTOM
R
L
FANS
TOP
BOTTOM
MAIN
SWITCH

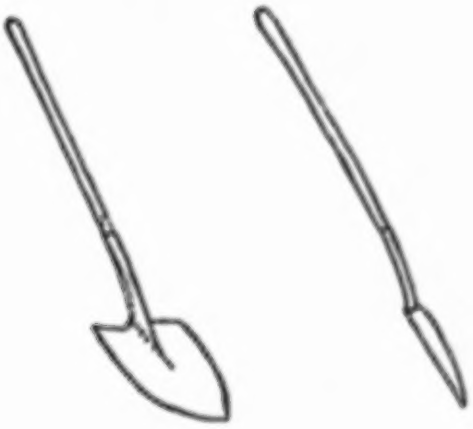
CONTROL PANEL

HORTICULTURAL MECHANICS PROJECT

Identifying Garden Tools

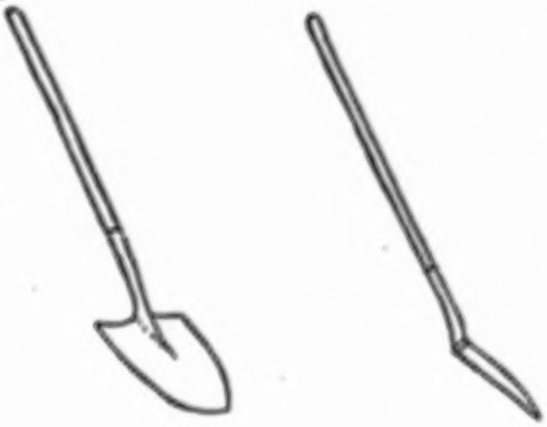
1. Long handled, round pointed shovel (straight shank)
2. Long handled, round pointed shovel (curved shank)
3. Long handled, square pointed shovel
4. D-handled, square pointed shovel (short handle)
5. D-handled, square pointed spade
6. Transplanting or balling spade (Sharpshooter)
7. Garden shovel
8. Scoop shovel
9. Garden hoe
10. Nursery and greenhouse hoe (round top)
11. Nursery and greenhouse hoe (square top)
12. Scuffle hoe
13. Warren hoe
14. Weeding hoe
15. Level headed rake
16. Metal bow rake
17. Rectangular lawn rake
18. Fan-shaped lawn rake
19. Long handled spading fork
20. D-handled fork (short handle)
21. Barn or manure fork (seed fork)
22. Pruning shears
23. Pruning shears
24. Hedge shears
25. Lopping shears
26. Grass shears
27. Cultivator
28. Cultivator
29. Cultivator
30. Weed cutter
31. Weed cutter
32. Drop shank pointed trowel
33. Straight shank pointed trowel
34. Transplanting trowel
35. Drop shank margin trowel
36. Dandelion weeder
37. Weeder
38. Hand hoe
39. Hand hoe and cultivator
40. Hand cultivator
41. Pruning saw (push cut)
42. Pruning saw (pull cut)

1.



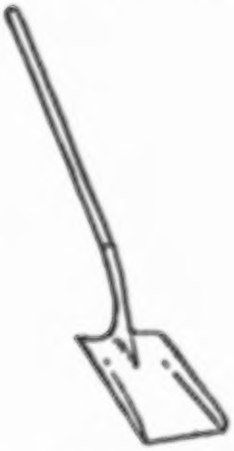
Long handled, round pointed shovel (straight shank)

2.



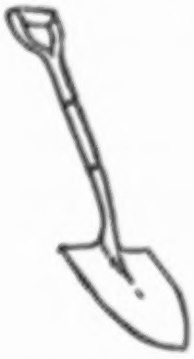
Long handled, round pointed shovel (curved shank)

3.



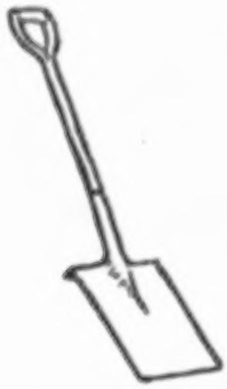
Long handled, square pointed shovel

4.



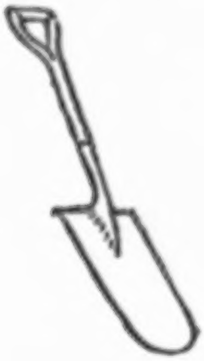
D-handled, round pointed shovel (short handle)

5.



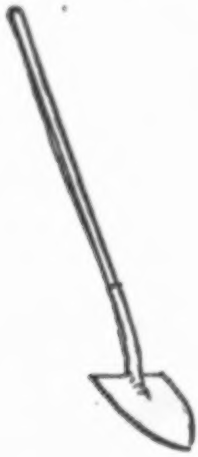
D-handled, square pointed spade

6.



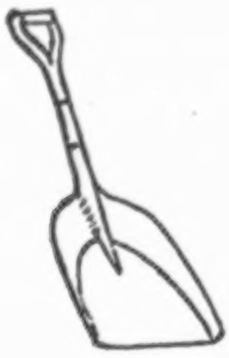
Transplanting or balling spade (Sharpshooter)

7.



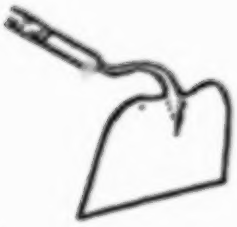
Garden shovel

8.



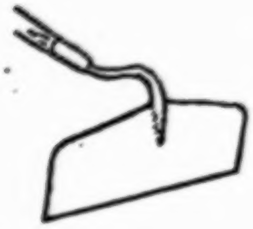
Scoop shovel

9.



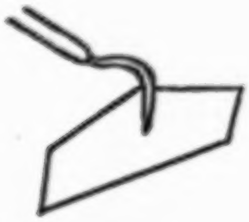
Garden hoe

10.



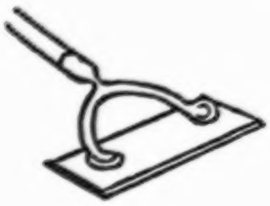
Nursery and greenhouse hoe (round top)

11.



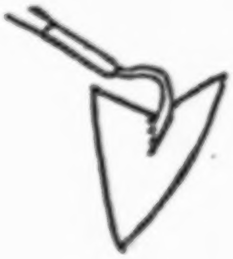
Nursery and greenhouse hoe (square top)

12.



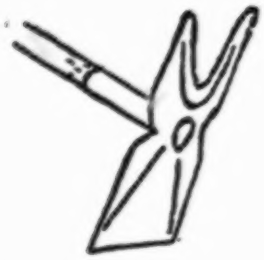
Scuffle hoe

13.



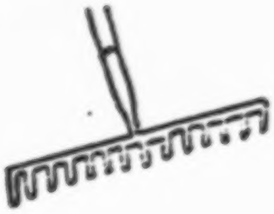
Warren hoe

14.



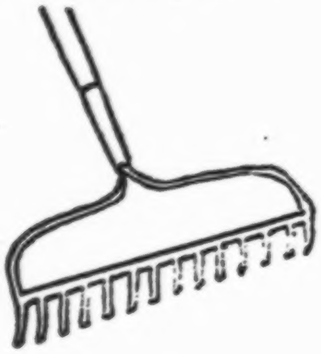
Weeding hoe

15.



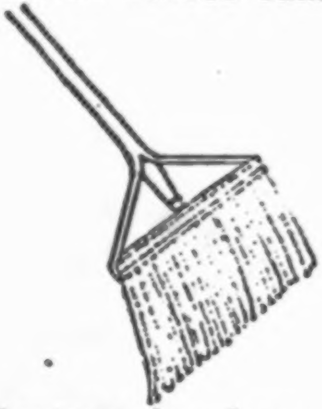
Level headed rake

16.



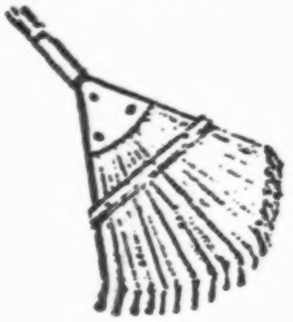
Metal bow rake

17.



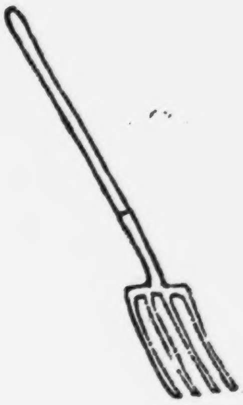
Rectangular lawn rake

18.



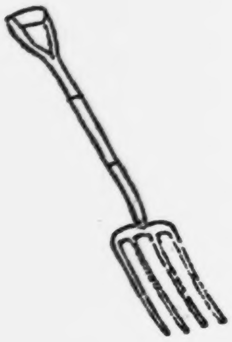
Fan-shaped lawn rake

19.



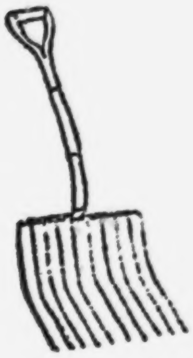
Long handled spading fork

20.



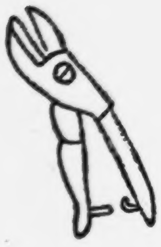
D-handled fork (short handle)

21.



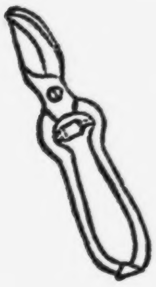
Barn or manure fork (seed fork)

22.



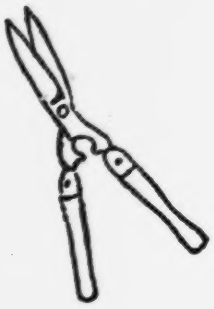
Pruning shears

23.



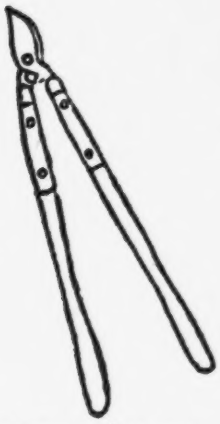
Pruning shears

24.



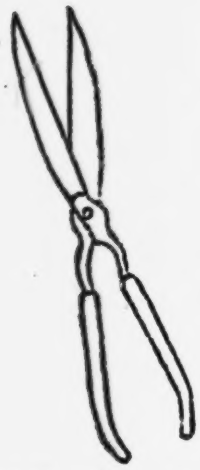
Hedge shears

25.



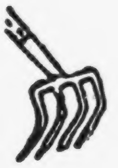
Lopping shears

26.



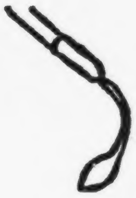
Grass shears

27.



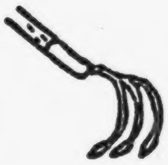
Cultivator

28.



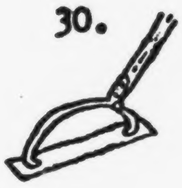
Cultivator

29.



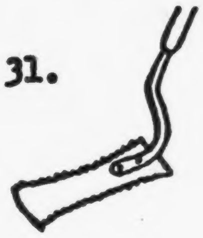
Cultivator

30.



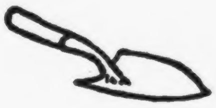
Weed cutter

31.



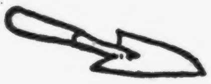
Weed cutter

32.



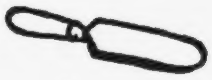
Drop shank pointed trowel

33.



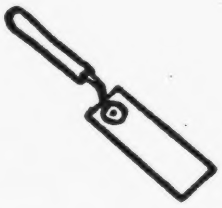
Straight shank
pointed trowel

34.



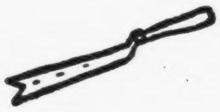
Transplanting trowel

35.



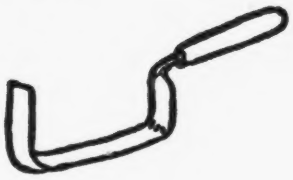
Drop shank margin trowel

36.



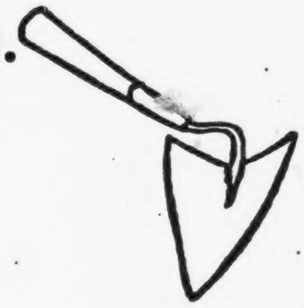
Dandelion weeder

37.



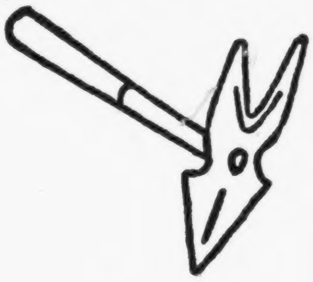
Weeder

38.



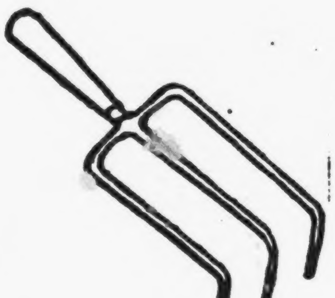
Hand hoe

39.



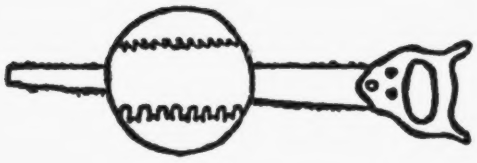
Hand hoe
and cultivator

40.



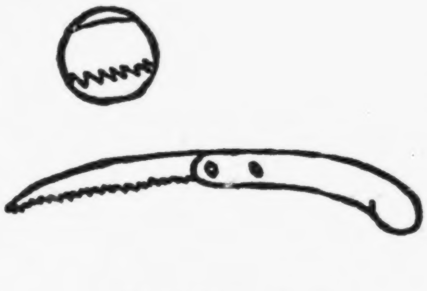
Hand cultivator

41.



Pruning saw
(push cut)

42.



Pruning saw
(pull cut)

HORTICULTURAL MECHANICS PROJECT

Sharpening a Hoe

Introduction

Hoes, like any tool, will do a better job and be easier to use if properly sharpened. A garden hoe is usually sharpened with a flat bastard file.

Procedures

1. Clamp the hoe firmly in a vise with the edge opposite the handle in an upward position as shown in Figure 1.
2. Grasp the handle of the file in the right hand, the end of the file in the left hand, and file diagonally toward the cutting edge in firm, steady movements as shown in Figure 2.
3. Maintain the original bevel of a new hoe uniformly across the cutting edge.
4. Remove the hoe from the vise and file off any burrs left on the opposite side of the bevel.

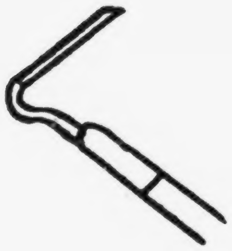


Figure 1. Position to clamp hoe in the vise.

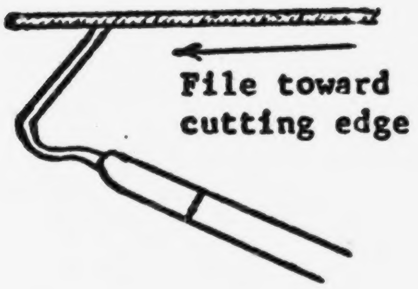


Figure 2. File blade so cutting edge is nearest the handle.

HORTICULTURE MECHANICS PROJECT

Making Signs and Markers for Ornamental Horticulture

Purpose

To outline a procedure for making attractive, durable signs for marking plants, demonstration plots or areas in ornamental horticulture.

Materials

1. Rough one-by or two-by lumber, depending on use, size and number of letters used
2. Orange and redwood or brown paint
3. Large (two or three inch) and small (one-fourth inch) paint brushes
4. Bench vise
5. Letter templates, pencils or other markers
6. Router or drill press and bits
7. Veining or core box router bits
8. Band saw, jigsaw or crosscut saw

Procedures

1. Select rough lumber of suitable dimensions for the particular sign to be made. Rough 1" x 4" x 6" or wider lumber should be satisfactory in most cases.
2. Lay out letter templates on the board to get proper spacing and find the length of board needed.
3. Draw the letters on the board to uniform size and style with a pencil. After laying out, the needed length of the board can be determined.
4. Use a router to rout out the letters. Caution: Wear safety glasses while using the router.
    a. Portable router--Place the board face side up securely in a wood bench vise. Select a veining or core box router bit the diameter of the width of the letters to be routed out. Set the router bit to a depth of 3/16-inch to 1/4 inch depending on the thickness of the board used. Carefully rout out the letters by following the lines in a freehand fashion.
    b. Drill Press--Another method of routing is to place a router bit in the drill press. Again select a veining or core box router bit of the correct diameter. Make sure the shank fits the drill chuck. Set the correct depth desired and rout out the letters freehand by moving the board under the stationary router bit.
5. Mark out the desired designs on the ends of the sign. See figures A, B and C for suggestions on designs.
6. Carefully cut out the desired end designs on a band saw or jigsaw. If these machines are not available, a crosscut saw can be used.

7. Determine how the sign is to be displayed. If the sign is to be hung, drill the proper holes for attachment. If the sign is to be placed on a stake, drill holes so it can be screwed to the stake or else nail it to the stake.
8. Paint the sign with a redwood or brown paint--two coats may be needed.
9. After the redwood paint has dried thoroughly, carefully paint the routed out letters with two coats of bright orange paint.
10. After the paint has dried, place the sign at the place to be marked. Properly constructed, the sign should be attractive, durable and attention getting. Maintain the sign by repainting as needed.

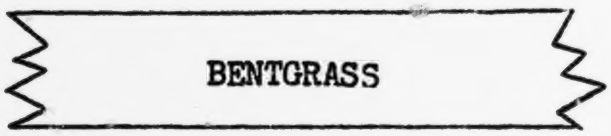


Figure A

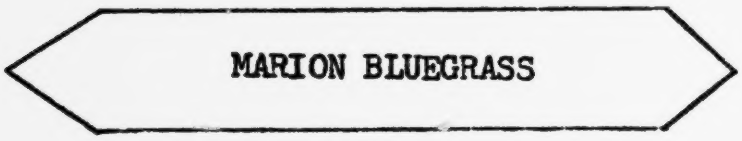


Figure B

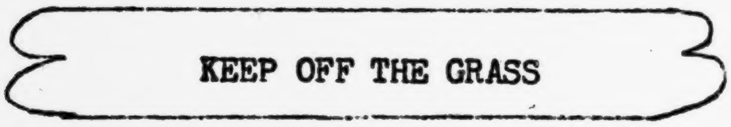


Figure C

HORTICULTURAL MECHANICS PROJECT

The Plant Grow and Study Mobile

Introduction

The Plant Grow and Study Mobile is designed to provide a place where plants may be grown and studied for more effective instruction in ornamental horticulture. The waterproof trays may be removed for closer study and experimentation. Relative humidity around the plants may be increased by setting the potted plants in vermiculite or similar material within the trays and wetting the vermiculite periodically. The frame is made from heavy one-inch tubing. The lights may be adjusted by the chains on each end of the mobile. Blackout covers and 12- x 18-inch shatterproof trays are available from Jewel Aquarium Company, 505 Armitage Avenue, Chicago, Illinois 60639.

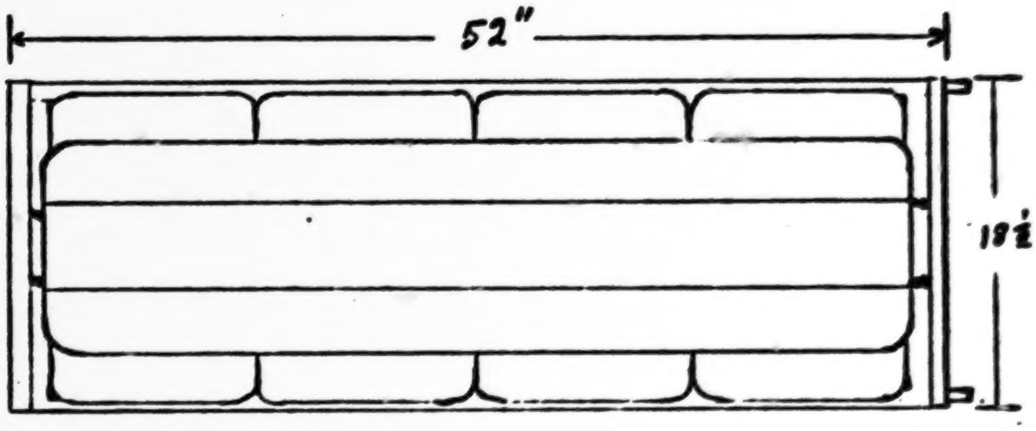
Bill of materials

Number of pieces	Size	Description
6	1" x 1" x 50"	Tubing, side rails
6	1" x 1" x 16½"	Tubing, end rails
2	1" x 1" x 163"(4" allowed for waste)	Tubing, upright ends
4	To fit 1" tubing, 2"-3" diameter	Casters
12	15"	Small chain and hooks
3	48" x 11 3/4"	Two-lamp reflector units
12	12" x 18" x 3"	Fiberglass trays with rolled edge

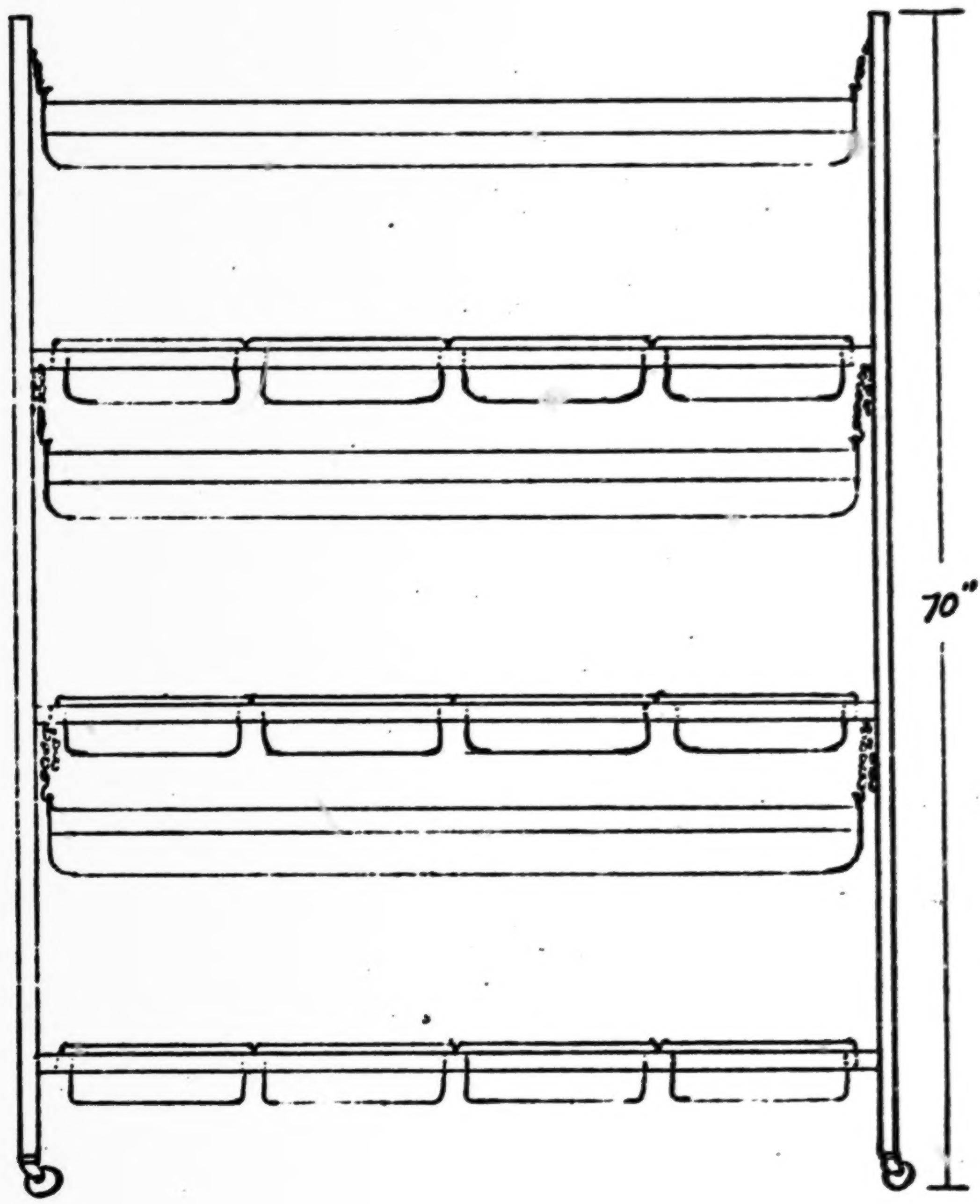
Procedures

Weld the side and end rails together to form three frames with outside dimensions of 18½" x 50". Attach the hooks for the light chains to the bottom of the frames. Next, bend the long pieces of tubing to the required dimensions and trim off the excess length. Weld the frames in place. Clean the frame and paint it the desired color. A light color is recommended. Next, attach the casters and lights. Wire the lights and put the trays in place. You are now ready to grow plants.

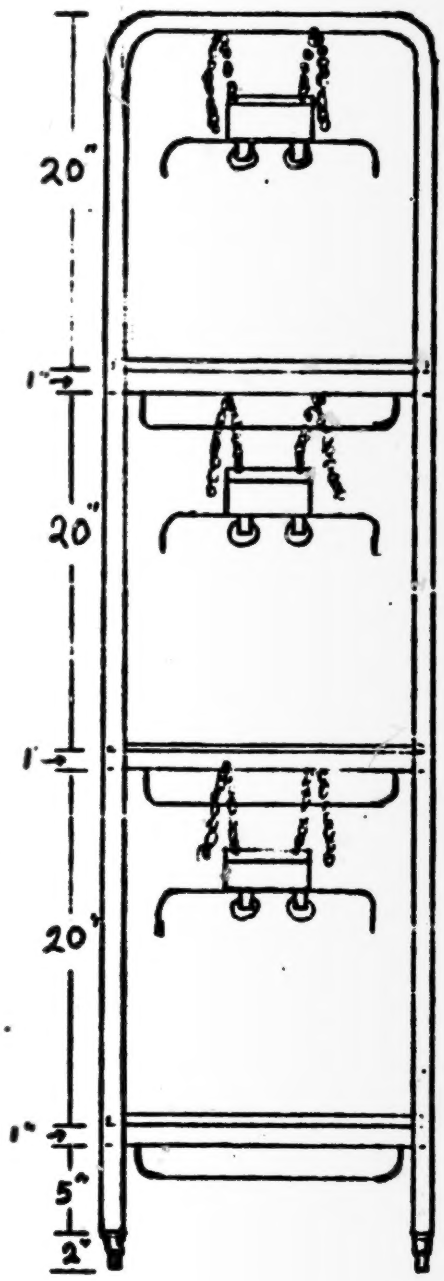
PLANT GROW AND STUDY MOBILE



TOP VIEW



FRONT VIEW


20"
1"
20"
1"
20"
1"
5"
2"

SIDE VIEW

APPENDIX D

ORNAMENTAL HORTICULTURE EXPERIENCE PROGRAM PLANNING GUIDE AND RECORD BOOK

USOE Project 6-1538-1-32
Experimental Materials

ORNAMENTAL HORTICULTURE

EXPERIENCE PROGRAM PLANNING GUIDE
AND
RECORD BOOK

Student's name__________________________________
Social security number____________________________
Student's age__________
Year in school__________
Home address__________________________________
School____
Title of course__________________________________
Instructor______________________________________
Record for the period____________________________
month day year
to
____
month day year

Division of Agricultural Education
College of Education,
University of Illinois Urbana, Illinois
February, 1967

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INTRODUCTION

This record book is written to provide any student enrolled in vocational agriculture or vocational ornamental horticulture a suggested list of beautification activities in the field of ornamental horticulture which could be carried out on his home grounds or in his home. As a planning guide, this record book is designed to suggest activities and skills in the various areas of ornamental horticulture. For convenience, records of each completed activity or skill can easily be recorded on the checklist pages provided. A systematic method of keeping records of plans, goals, and accomplishments is also provided.

This planning guide can be used by students who have supervised agriculture experience programs or may be substituted as an individual experience program in the area of ornamental horticulture.

It is assumed that every student has a yard where some of the suggested activities can be carried out. As a potential home owner, each student can develop practical and worthwhile knowledges and skills in the area of ornamental horticulture by using this guide, and at the same time can improve and beautify his home surroundings.

Suggested activities in ornamental horticulture beautification that can be carried on inside the home are listed. These activities can be interesting and informative as they are carried out. Many skills in ornamental horticulture can be developed by carrying on such a project.

In addition, this book contains a section for keeping records of receipts and expenses, labor, photos and news clippings and instructor's visits. A record of FFA leadership and a student diary is also provided.

It is hoped that this record book will be valuable to the student as a source list of activities and skills to be developed in the area of ornamental horticulture. It is also hoped that surroundings, both inside and outside the home, can be beautified and made more pleasant by carrying on some of these suggested ornamental horticulture activities.

Students who are engaged in placement-employment programs should keep their records in one of the occupational experience program record books designed for vocational agriculture students. Students who are engaged in a self-employment program involving production or other money-making activities may wish to select and use a production-type record book.

AGREEMENT

Name of student______________________________ School_______________________

Home address_________________________________ Age__________________________

Year in school________ Title of course___________________________________

A. STUDENT AGREEMENT

1. I agree to make a study of the beautification activities and skills in ornamental horticulture that I can carry out on my home grounds or in my home. My parents and instructor will help set up feasible plans and goals for me to accomplish.

2. I agree to develop plans and goals for my home experience program.

3. I agree to keep a record of plans, goals, and activities accomplished as well as records of receipts, expenses, labor, instructor's visits, leadership, and other activities.

4. I agree to carry out the planned activities and skills and assist in specialized activities connected with this program.

5. I agree to carry out these activities as beautification and improvement projects and develop related ornamental horticulture skills.

B. PARENTAL AGREEMENT

1. I agree to assist in the achievement of this home experience program insofar as I am able.

2. I agree that the student will not be expected to pay any costs incurred in this work except for items which are his own property.

C. INSTRUCTOR AGREEMENT

1. I agree to give needed instruction in ornamental horticulture and in home beautification and improvement.

2. I agree to assist in planning the home beautification program with the student and his parents.

3. I agree to provide individual instruction and supervise work done on this program.

________________________ ________________________ ________________________

Student Parent Instructor

HOME GROUNDS AND PLANT INVENTORY

One way to start any project is to identify the existing situation. This can be done by taking an inventory of the yard or home grounds to be improved and beautified. Following is an outline to follow when taking the inventory.

A. Sketch a view of the present yard and home grounds on the following page. Things to locate on the view include:

   1. Total area to be improved.
   2. House and other buildings.
   3. Fences and sidewalks.
   4. Areas or materials which need improvement, removal or change.
   5. Trees, shrubs and grasses.

B. Identify the trees, shrubs and grasses on the sketch. List common and scientific names of the plants below.

C. Inventory the types of plants in your home.

1.
2.
3.
4.
5.
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8.
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11.
12.

SKETCH OF AREA TO BE IMPROVED (PRESENT SITUATION)

GOALS AND IMPROVEMENTS

Evaluate the present situation. What changes should be made? How much work will it take to make these changes? How large a project can you undertake? How much will it cost? What benefits and satisfactions will be derived from the completed project? These are some of the questions to consider in evaluating the present situation, planning changes and setting up goals for your beautification program. Talk your plans over with your parents and instructor. Develop long-range plans and goals which can actually be done.

After evaluation, planning and setting up goals, sketch a view of the yard or grounds that fits into your plans and feasible goals. The view should include all the changes necessary and show how the completed project will look.

Things the plan should include are:

1. General cleanup, removal of any unsightly trash or material.
2. Location or relocation of fences, sidewalks, patios, etc.
3. Proposed trees, shrubs and grasses. Be specific in location and identification.
4. Location of mailbox.
5. Location of window boxes, rose trellises, and lawn furniture.

SKETCH OF AREA TO BE IMPROVED (PROPOSED SITUATION)

EXPERIENCE PROGRAM PLANS

Now that you have taken an inventory of the home grounds, evaluated the present situation, and made plans and set goals for future work and improvement in ornamental horticulture, you will want to select a place to start. You will want to put your plans into action. It will not be possible to make great changes all at one time, but the thing to do is to get started and involved in some aspect of the beautification program. Following is a list of suggested jobs to do and ways and means of accomplishing them.

General cleanup program

This sounds like a lot of hard work. It is, but you must evaluate it in terms of the benefits you will derive from pleasant and beautiful surroundings. Really, cleanup involves activities that should be done anyway. Some situations will require a lot of work, others will be in good shape and not much time will need to be devoted to cleanup. For situations where unsightly materials have been allowed to accumulate, the first job is to remove them.

Below is a list of general cleanup activities which may need to be done. Study your home situation and put a check mark by those activities that need attention. Add additional activities which need to be done at the bottom of the list. Upon completion of each activity, enter the date completed.

Cleanup activity	Needs attention	Date completed
1. Remove dead trees or shrubs.		
2. Remove and dispose dead branches.		
3. Remove junk, trash, and woodpiles which have accumulated around the house or grounds.		
4. Provide a specific storage place for all lawn and horticultural equipment.		
5. Repair or remove broken picnic tables or lawn furniture.		
6. Fill in low places and grade the grounds to provide for drainage.		
7. Remove, repair or replace fences, sidewalks, step railings, and porches.		
8. Remove or transplant trees, shrubs or flowers to fit the long-range plan.		
9. Make provisions for the driveway.		

Cleanup activity	Needs attention	Date completed
10. Pick up nails and broken glass.		
11. Remove unsightly rocks.		
12.		
13.		
1[illegible].		
15.		

Grounds maintenance practices

In addition to general cleanup activities, your home yard or grounds provide an excellent opportunity to develop knowledges and skills in grounds maintenance. You will study maintenance practices in the classroom which can actually be applied on your home grounds.

Below are listed several maintenance practices that can be accomplished on your home grounds or in your yard.

Check the "Opportunity" column if it possible for you to do this activity. Check the "Activity Completed" column when the activity has been accomplished. Use the "Scope" column to indicate the number of times a particular activity is performed, the number of plants treated, or the size of the area maintained as it pertains to the suggested practices.

Grounds maintenance practices	Opportunity	Activity completed	Scope
1. Mow the lawn.			
2. Trim or prune ornamental trees.			
3. Fertilize the lawn, trees, shrubs, flowers.			
4. Apply herbicides.			
5. Apply insecticides.			
6. Water the lawn, trees, shrubs or flowers.			
7. Repair trees.			
8. Brace trees.			

Grounds maintenance practices	Opportunity	Activity completed	Scope
9. Prevent sunburn.			
10. Prevent winter injury.			
11. Prevent insect damage and disease.			
12. Set up, adjust and move the sprinkler.			
13. Edge the lawn.			
14. Operate the sprayer.			
15. Operate the duster.			
16. Prune deciduous shrubs.			
17. Prune evergreen shrubs.			
18. Mix chemicals.			
19. Stake trees.			
20. Set up a rain gauge.			
21. Record precipitation from a rain gauge.			
22. Trim hedges.			
23. Trim shrubs.			
24. Mulch trees and shrubs.			
25.			
26.			
27.			
28.			
29.			
30.			

Mechanical maintenance practices

In order to carry out the grounds maintenance practices listed previously, you will probably be working with various horticulture tools and equipment. This will provide an opportunity for you to develop knowledges and skills in the area of horticultural mechanics maintenance.

Below are listed several mechanical maintenance practices that may be accomplished by working with horticultural machinery and equipment. Check the "Opportunity" column if it is possible for you to do this activity. Enter the date in the "Date Completed" column when the activity has been accomplished.

Mechanical maintenance practices	Opportunity	Date completed
1. Sharpen mower blades.		
2. Adjust mower height.		
3. Calibrate the sprayer.		
4. Flush and clean the sprayer.		
5. Adjust the fertilizer spreader.		
6. Select horticultural tools and equipment.		
7. Sharpen horticultural tools.		
8. Clean and oil horticultural tools.		
9. Recondition horticultural tools and equipment.		
10. Operate the chain saw.		
11. Operate the hedge trimmer.		
12. Calibrate the irrigation system.		
13. Adjust gasoline engines.		
14. Change oil and maintain gasoline engines.		
15. Use horticultural tools and equipment safely.		
16.		
17.		
18.		
19.		
20.		

Improvement and beautification activities

Once the cleanup activities have been completed and maintenance skills developed, you will want to start some improvement and beautification projects on your home grounds. There are many possibilities. By working toward your proposed and planned program, you can start with a large project and supplement it with smaller, less time-consuming projects.

A planned program with definite goals will help you evaluate your progress. Below is a list of improvement and beautification activities. Check the "Planned" column if the activity is in your long-range plans. Upon completion of the planned activity, enter the date in the "Date Completed" column.

Improvement and beautification activities	Planned	Date completed
1. Plant new trees.		
2. Plant new shrubs.		
3. Seed or plug a new lawn.		
4. Plant flowers.		
5. Relocate and replant trees.		
6. Relocate and replant shrubs.		
7. Renovate the lawn.		
8. Grade the lawn.		
9. Reseed bare spots.		
10. Plant sprigs.		
11. Place plugs.		
12. Repair bare spots.		
13. Take soil samples.		
14. Apply fertilizer.		
15. Apply lime.		
16. Repair old fences.		
17. Paint fences.		
18. Build fences.		

Improvement and beautification activities	Planned	Date completed
19. Build lawn furniture.		
20. Repair lawn furniture.		
21. Paint lawn furniture.		
22. Paint house or other buildings.		
23. Build a new sidewalk.		
24. Improve the driveway.		
25. Landscape the yard.		
26. Prepare the public, private and service areas.		
27. Build a concrete patio.		
28. Lay a stone patio.		
29. Lay a stone walk.		
30. Build a barbecue pit.		
31. Make a window box.		
32. Build a rose trellis.		
33. Build a pool.		
34. Build a pond.		
35.		
36.		
37.		
38.		
39.		
40.		
41.		

Horticultural activities within the home

There are numerous activities that can be carried out with ornamental plants within the home. House plants beautify and make the surroundings more pleasant. It is also interesting to watch them grow. Many horticultural knowledges and skills can be learned by growing and taking care of plants indoors.

Everyone has an opportunity to start some type of plant project in his own home. Below are listed some plant projects or indoor activities in the area of ornamental horticulture that may be carried on within his home. Check the "Opportunity" column if it is possible for you to do this activity. Check the "Activity Completed" column when the activity has been accomplished.

Horticultural activities within the home	Opportunity	Activity completed
1. Care for the house plants presently growing in my home.		
2. Learn the common and scientific names of house plants growing in my home.		
3. Learn the identifying characteristics of house plants growing in my home.		
4. Obtain and start growing different kinds of house plants in my home.		
5. Prepare special arrangements of house plants and flowers in my home.		
6. Build attractive containers for potted plants.		
7. Build hangers for potted plants.		
8. Make a moss stick and grow a climbing vine.		
9. Prepare a terrarium and maintain it in an attractive place.		
10. Arrange blooming plants around a background of green foliage plants.		
11. Add flowering plants to foliage plants to brighten a winter window garden.		
12. Grow "masculine plants" in your room or office.		
13. Construct an attractive centerpiece for the dining room table.		
14. Place a plant in front of a mirror to get twice the effect from a plant arrangement.		

Horticultural activities within the home	Opportunity	Activity completed
15. Make up and display a dish garden of cactus and succulents.		
16. Sink spring bulbs outdoors for three months of cold weather, then bring indoors to bloom.		
17. Move potted house plants outdoors during the summer.		
18. Move potted plants to the outdoor window garden between spring-blooming plants and summer-blooming plants.		
19. Build a plant box to match the back-yard fence.		
20. Combine planters, green foliage plants and flowering plants into an attractive setting to enhance the beauty of the living room.		
21. Grow plants under artificial light.		
22. Grow lilies for Easter.		
23. Grow poinsettias for Christmas.		
24. Grow chrysanthemums for Thanksgiving.		
25. Develop a creative and attractive floral design which fits into my home situation.		
26.		
27.		
28.		
29.		
30.		

New horticultural skills

By carrying on some of the suggested ornamental horticulture activities within your home, you will have an opportunity to learn and develop many new horticultural skills.

Below are listed several skills which you may have an opportunity to develop. When the activity has been accomplished enter the date in the "Date Completed" column. Use the "Scope" column to indicate the number of times an activity was performed or the number of plants or seeds treated.

A. Plant propagation skills

New horticultural skills	Date completed	Scope
1. Sterlize soil.		
2. Sterilize equipment.		
3. Mix mediums.		
4. Prepare a medium for cuttings.		
5. Make cuttings.		
6. Make buds.		
7. Treat cuttings with hormones.		
8. Stick cuttings.		
9. Pot cuttings.		
10. Dip bulbs before planting.		
11. Dip corns before planting.		
12. Treat seeds with acids.		
13. Pinch plants.		
14. Prune ornamental plants.		
15. Water plants.		
16. Prepare fertilizer solutions.		
17. Spray hormone solutions for blossom set.		
18. Inject hormones.		
19. Force flowers.		
20. Bring flowers into bloom.		
21. Prepare a seed flat.		
22. Prepare a germination media.		
23. Sow seeds (broadcast or rows).		

New horticultural skills	Date completed	Scope
24. Treat seeds (fungicides, scarification, stratification).		
25. Label seedlings, cuttings and plants.		
26. Remove seedlings from seed flats.		
27. Pot seedlings.		
28. Select potting media.		
29. Mix potting media.		
30. Apply growth regulators.		
31. Make air layers.		
32. Remove air layers.		
33. Hasten maturity.		
34. Retard maturity.		
35. Pinch plants.		
36. Disbud plants.		
37.		
38.		
39.		
40.		

B. Floricultural skills.

New horticultural skills	Date completed	Scope
1. Use a knife in making flower cuts.		
2. Use a shears in making flower cuts.		
3. Select and prepare the flower holder.		
4. Prepare the container.		
5. Prepare and arrange the right flowers and combinations for specific use.		
6. Recut stems.		
7. Trim flowers.		
8. Remove foliage under water.		
9. Boil and sear the stems.		
10. Wrap flowers.		
11. Arrange different designs.		
12. Locate and display flowers for ultimate attraction.		
13. Select proper tools.		
14. Use tools properly.		
15. Place flowers in containers.		
16.		
17.		
18.		

RECORDS AND REPORTS

Record of Receipts

Date	Item	Received from or sold to	Amount	

Record of Expenses

Date	Item	Paid to	Amount	

Labor Record

Date	Activity	Hours worked

Personal Expense Record

Date	Education		Recreation		Contributions		Personal	

Date	Education		Recreation		Contributions		Personal	

Photos and News Clippings

Record of Instructor's Visits and Individual Instruction

Date	Plans, comments and recommendations of instructor

FFA Leadership Record

A. FFA Leadership (offices and committee memberships)

Office or committee	Year and length of service	Scope (local, district, state)

B. FFA Activities (FFA contests, conventions and other activities)

Date	Activity	Nature of participation and placing

C. FFA Cooperative Activities (group projects, FFA cooperation and community projects)

Date	Activity

D. Other Leadership Activities (membership and offices in 4-H, church groups, classes, band and athletics)

Activity	Year and length of service	Comments

Student Diary

This diary should be used to keep weekly records of horticultural or other activities. A minimum of two entries per week is suggested.

Date	Activities

Date	Activities

APPENDIX E

ORNAMENTAL HORTICULTURE NEWSLETTER

LETTERS TO TEACHERS REGARDING FIELD TESTING

ORNAMENTAL HORTICULTURE NEWSLETTER

Division of Agricultural Education
University of Illinois
December 1966

About this newsletter

Since this is the first time you have received a newsletter concerning the Ornamental Horticulture Project, you may be interested to know what you may expect from it.

During the past three months, the Ornamental Horticulture Project staff members have visited several departments of teachers who attended the institute. We thought you might be interested in what others are doing toward launching ornamental horticulture programs in their schools. Also, we have received several comments on the laboratory exercises and source units from instructors who have used them in their teaching programs.

If you have anything to share with others who are interested in ornamental horticulture, please send it to the Division of Agricultural Education and we will include it in the next newsletter.

Activities being carried on by members of the Ornamental Horticulture Institute

Bill Cinnamon of Brimfield has been discussing with his school board and superintendent of schools the possibility of a school greenhouse.

Carroll Johnson of Payson is integrating ornamental horticulture into his Vocational Agriculture II course. He has been accumulating pots, stakes, and potting materials for work in ornamental horticulture. Mr. Johnson is using some shelves in the shop with an exposure to a window to do his rooting and plant growing.

At Amboy High School Jim Becker intends to teach ornamental horticulture as an integrated unit to all his students in vocational agriculture. He has acquired a growlux light to use in growing plants in the vocational agriculture laboratory.

Michael Yocam of Paola, Kansas, reported on November 1 that he was using the curriculum materials developed last summer and that he was constructing a light chamber to conduct experiments on light and darkness. In an earlier letter Mike reported that he was in the process of clearing and fencing five acres of land for horticulture. Two acres will be used for liner stock (trees and shrubs), one acre for orchard, and one acre for vegetable production. A greenhouse, storage shed, frames, and work room will occupy about one-half acre and one-half acre will be used for turf plots. The local Rotary Club is furnishing Paola High School with 1,500 trees for lining out. Mike will teach an adult course on landscaping this winter.

Ed Sauer of Fisher will integrate ornamental horticulture into the regular vocational agriculture courses. He has developed a simulated greenhouse in the shop where he can regulate light and to some extent humidity. Ed has his students designing landscapes and planting shrubs at private homes in Fisher.

L. M. Huggins of Rockton is making extensive changes in his facilities for teaching ornamental horticulture. He is in the process of building a school greenhouse using plastic as his covering material. He also is accumulating pots, flats, and misting equipment. Mr. Huggins has built a climatarium with two levels in which he is able to control light, humidity, and temperature. The climatarium would be worth looking over if you are in Mr. Huggin's area.

At Forreston, Dean Finch is teaching ornamental horticulture as an integrated unit in his regular vocational agriculture classes. He has built a small plastic-covered frame which he called a misting chamber. He uses the mister off a Windex window cleaner bottle to mist the plants in the chamber.

Albert Tieken of Dixon has used some of the source units and laboratory exercises. He was pleased with the manner in which they helped him teach the areas. He has a shelf built in the shop with an exposure to a window where the FFA chapter members are rooting plants and growing ornamentals for sale.

At Villa Grove, Rolla Mitchell is teaching a separate course in ornamental horticulture called vocational ornamental horticulture to tenth and eleventh graders. He has ten students enrolled in the class, all of whom get their supervised experience programs on a local golf course that the class is responsible for maintaining. Mr. Mitchell's class is the result of working closely with the federally sponsored Work Study Program this summer. He has installed a climatarium since this summer and has started to use an area of the school ground as a turf plot demonstration.

Glenn Curl of Rochelle intends to offer a separate course called ornamental horticulture to juniors and seniors for the second semester of this year. He is also integrating ornamental horticulture into his regular vocational agriculture classes at the sophomore level.

Bob Brown of DeKalb is in the process of moving into a new facility and, of course, is busy getting things oriented. He has purchased a climatarium for classroom propagation work.

Robert Mills reports that his school system is expending and adding a vocational complex to the present high school. The vocational agriculture facility is presently being completed and Mr. Mills plans to move in next semester. Mr. Mills will erect a plastic greenhouse and hotbeds after he is in the new facility. He has an automatic controlled germinator, and plans to build a growth chamber. Mr. Mills is teaching ornamental horticulture as an integrated course in the regular vocational agriculture program.

At Alton ornamental horticulture is taught to two groups in a course called suburban living. Mr. Eagleton is investigating the possibility of placing boys for work experience in a nursery operated by the school district.

At Lincoln High School Bob Dorch plans to teach ornamental horticulture to his agricultural occupations class of six students. Mr. Dorch is planning a two- or three-month leave of absence to visit eastern Asia with a Rotary Club delegation and, as a result, will begin his ornamental horticulture classes late in the spring.

Clarence Fluegel of Oswego will teach ornamental horticulture as an integrated unit to freshmen and sophomores. Mr. Fluegel is faced with a problem of having his pupils at a new school and his ornamental horticulture facilities at the old school. He has to transport his students from one school to the other. At the old school Mr. Pluegel has a plastic covered structure in the shop where he is able to control light and heat.

Article about Ornamental Horticulture Institute

Dr. Cayce Scarborough, editor of The Agricultural Education Magazine, has informed us that an article describing the 1966 Ornamental Horticulture Institute at the University of Illinois will be published in the February edition.

Comments of teachers on source units and laboratory exercises

Comments from teachers who have used source units and returned evaluation forms indicate that the units are helpful in teaching ornamental horticulture. Some teachers have reported on as many as eight source units or laboratory exercises. The suggestions we are receiving are a great aid in helping us orient our efforts toward more effective assistance to you in your ornamental horticulture programs.

Extra copies of units and exercises

We have approximately 25 extra copies of each of the source units and laboratory exercises. If you need additional copies of these materials, they are yours for the asking as long as the supply lasts.

12/16/66psg

Division of Agriculture Education
University of Illinois
358 Education Building
February 1, 1967

To: Teachers who were enrolled in the Ornamental Horticulture Institute

From: Paul Hemp, Institute Director

Subject: Try out of student record book

If you have students who are carrying home beautification projects or other ornamental horticulture improvement projects, you may wish to make use of the enclosed planning guide and record book. This book needs to be tested in the field to determine its value as a student record.

Use the tear sheet to order additional copies. If you order additional copies, you should plan to use them with students and report back to us your evaluations and suggestions by June 1, 1967.

- - - - - - - - - - - - - - - - - Tear Sheet - - - - - - - - - - - - - - - - -

__________ Yes, I am interested in having my students use the Ornamental Horticulture Experience Program Planning Guide and Record Book during the spring semester, 1966-67.

Please send me__________ copies of the book to try on an experimental basis.

Signed__________________________

School__________________________

__________ Return to Paul Hemp, 358 Education Building, Urbana

UNIVERSITY OF ILLINOIS COLLEGE OF EDUCATION

DEPARTMENT OF VOCATIONAL
AND TECHNICAL EDUCATION
EDUCATION BUILDING
URBANA, ILLINOIS 61801
AREA CODE 217 333-0807

August 19, 1966

To: Teachers participating in the Ornamental Horticulture Project

Subject: Distribution, use, and evaluation of source units

Under separate cover I am sending you several source units which were developed this summer in the Ornamental Horticulture Institute. Within two or three weeks you will receive a shipment of student laboratory exercises to use in your instructional program.

I hope you will be able to field-test these materials and provide us with evaluative information to use in refining and improving both the units and the exercises. A supply of evaluation sheets will be enclosed with each shipment you receive. As you review these materials and contemplate their possible uses please keep in mind these two points:

1. No teacher is expected to teach all of the problem areas covered by these units.
2. The source units are not a self-contained teaching kit or teaching plan. They should help you plan the teaching of a particular problem area but additional ideas and information will have to be added to each source unit.

Obviously, you are not expected to complete an evaluation form for a particular source unit or laboratory exercise until you have used the unit or exercise.

To help you plan appropriate laboratory activities for your students I am enclosing a list of laboratory exercises which are soon to be sent to you. We have not attempted to identify the problem area which each laboratory exercise fits best. Again, it is your prerogative to use or not to use each laboratory exercise.

I hope you have a successful school year and that the curriculum materials from the Ornamental Horticulture Project prove useful in your teaching.

Sincerely yours,

Paul Hemp

Paul E. Hemp, Director
Ornamental Horticulture
Research Project

PEH:npm

Enclosure

UNIVERSITY OF ILLINOIS COLLEGE OF EDUCATION

DEPARTMENT OF VOCATIONAL
AND TECHNICAL EDUCATION

EDUCATION BUILDING
URBANA, ILLINOIS 61801
AREA CODE 217 333-0807

August 19, 1966

To: Teachers who agreed to field-test ornamental horticulture materials.

Subject: Distribution, use, and evaluation of curriculum materials.

I was pleased to hear that you are willing to use and evaluate a number of source units developed in the Ornamental Horticulture Institute this summer. Under separate cover I am sending you the source units which are ready plus some evaluation sheets which you are to complete and return to me as soon as you teach the problem area. Since you may not choose to teach a particular problem area until late in the school year, the deadline for returning the evaluation sheets will be May 31, 1967. Of course, if you complete the evaluation sheets before that time I will appreciate receiving them.

As you will discover, the source units are not complete teaching kits. You will need to draw on other resources to teach the areas covered. Also, the source units are really first drafts of the final product. Your assistance is needed in the revision and improvement of these units.

The ornamental horticulture research staff is preparing a series of laboratory exercises for student use. About September 1, I will send you a shipment of these exercises along with some evaluation sheets. Please review these exercises and use as many of them in your teaching as you can. In return I hope that you will fill out an evaluation sheet for each laboratory exercise that you use.

I appreciate your willingness to assist in the field testing and evaluation of these materials. If you have any suggestions regarding other ornamental horticulture materials which need to be developed, please write me about them.

Sincerely yours,

Paul Hemp

Paul Hemp, Director
Ornamental Horticulture
Institute.

PH:sh
enclosure

UNIVERSITY OF ILLINOIS COLLEGE OF EDUCATION

DEPARTMENT OF VOCATIONAL
AND TECHNICAL EDUCATION
DIVISION OF AGRICULTURAL EDUCATION

EDUCATION BUILDING
URBANA, ILLINOIS 61803
AREA CODE 217 333-0807

September 13, 1966

To Teachers Cooperating in the
Ornamental Horticulture Project

Subject: Curriculum Materials

By this time you should have received the source units, laboratory exercises, and evaluation forms which are available at this time. Teachers who attended the summer institute should have received 31 source units and 16 laboratory exercises. Other teachers should have received 16 laboratory exercises and as many source units as requested on the checklist.

If you do not have the materials which you requested or should have, please let me know. If you need additional evaluation sheets during the year, please drop me a card requesting additional copies.

Sometime in October I hope to send you an additional shipment of laboratory exercises. I hope you will try out as many of these exercises with your students as possible. As soon as you have used and evaluated a source unit or a laboratory exercise, I would appreciate receiving a completed evaluation form so we can begin the job of revising and improving these materials.

Sincerely yours,

Paul E. Hemp

Paul E. Hemp
Associate Professor
Agricultural Education

PEH:psg

APPENDIX F

EVALUATION FORM FOR TEACHERS' SOURCE UNITS

EVALUATION FORM FOR LABORATORY EXERCISES

ORNAMENTAL HORTICULTURE INSTITUTE FORM 1

ORNAMENTAL HORTICULTURE INSTITUTE FORM 2

ORNAMENTAL HORTICULTURE INSTITUTE FORM 3

FINAL REPORT FROM PILOT SCHOOLS

EVALUATION FORM FOR TEACHERS' SOURCE UNITS

1. Name of problem area______________________________

2. Use of source unit:

   a. Number of class periods used in the teaching of this problem area__________

   b. Number of students taught __________

   c. Grade level of students taught __________

3. What changes, additions, or corrections should be made in each of the following sections? (Use back of this page for additional comments.)

   a. Content or subject-matter outline

   b. Ways of starting problem area

   c. Suggested questions and answers

   d. Suggested laboratory exercises

   e. Student and teacher references and aids

4. Should more subject matter (answers to questions) be included in this source unit?______________________________

5. List the references which were most valuable to you and your students.

   ____

   ____

   ____

6. What other suggestions do you have for improving this source unit?

   ____

   ____

   ____

   ____

7. Was this source unit your main source of help in teaching this problem area? ______. If not, what was your main source of help?__________

____

____

8. Did you discover any additional teaching aids which should become a part of this source unit? (Examples--diagrams, check lists, charts)

____

____

____

____

(Note: If you care to send us a corrected copy of this source unit which has your suggestions written in, please do so.)

EVALUATION FORM FOR LABORATORY EXERCISES

1. Name of laboratory exercise ______________________________

2. Grade level of student using exercise ______________________

3. Number of students who completed this exercise ______________

4. How much time was required to complete this exercise? Label your answer in terms of hours or days. ______________________________

5. Is this exercise appropriate for high school instruction? ____________
   Why? ______________________________
   ____

6. Did this exercise arouse and create interest in the subject covered?
   ____

7. Was too much or too little material covered? ______________
   ____

8. Were explanations clear? ____________ How should they be changed?
   ____
   ____

9. Were procedures well organized? ________ How should they be improved?
   ____
   ____
   ____

10. Should this exercise be revised and made available to other ornamental horticulture classes? ______________________________

Note to teacher. Please complete one evaluation form for each exercise used or, if you prefer, duplicate this form and have each student evaluate the exercises they complete.

ORNAMENTAL HORTICULTURE INSTITUTE FORM 1

Information Concerning the 1965-66 Program
Conducted in Cooperating Schools

1. Name ____

2. Name of school ____________________________________

3. Address of school __________________________________

4.

Titles or separate courses taught in ornamental horticulture	Number enrolled	Grade level of students
1.		
2.		
3.		
4.		
5.		
6.		

5. Names of units or problem areas taught as a part of the regular vocational agriculture program.

   1.
   2.
   3.
   4.
   5.
   6.
   7.
   8.
   9.
   10.

6. How many students received instruction in ornamental horticulture as a part of the regular vocational agriculture program? ________________

7. What grade levels were taught ornamental horticulture as a part of the regular vocational agriculture program? ____________________________

8. How many students were involved in the placement-employment programs?
____

9. What was the duration of these placement-employment programs in weeks?
____

10. List the names of training stations used in the placement-employment program.

    1.
    2.
    3.
    4.
    5.
    6.
    7.
    8.
    9.
    10.
    11.
    12.
    13.
    14.

ORNAMENTAL HORTICULTURE INSTITUTE FORM 2

Information Sheet Concerning 1966-67 Program to be Conducted in Cooperating Schools

1. Name ______________________________

2. Name of school administrator ______________________________

3. List titles of separate courses to be taught in ornamental horticulture during 1966-67.

   1.

   2.

   3.

   4.

   5.

   6.

4. What enrollment do you expect in separate ornamental horticulture courses during 1966-67? ______________

5. What enrollment do you expect in regular vocational agriculture classes in which ornamental horticulture is taught? ______________

6. What is the grade level of anticipated enrollees in ornamental horticulture during 1966-67? ______________

7. Give your complete teaching schedule or assigned duty for the 1966-67 school year.

   Period 1

   2

   3

   4

   5

   6

   7

   8

   9

   10

8. Indicate the problem areas you plan to teach during the 1966-67 school year by listing the course in which each area will be taught.

Name of problem area	Name of course in which area is to be taught
1. Selecting growing mediums	
2. Potting plants	
3. Plant growth and development	
4. Propagating plans asexually	
5. Selecting and using plant growth substances	
6. Propagating plants sexually	
7. Sterilizing soil	
8. Constructing special structures	
9. Transplanting seedlings and cuttings	
10. Propagating greenhouse plants	
11. Growing lilies for Easter blooming	
12. Controlling light, temperature, and humidity in a greenhouse or climatarium	
13. Arranging bouquets and floral pieces	
14. Judging flowers	
15. Storing and caring for cut flowers	
16. Sodding lawns	
17. Establishing a lawn by seeding	
18. Renovating lawns	
19. Maintaining an established lawn	
20. Container plant production	
21. Cultivating, fertilizing, mulching, and watering nursery plants	

Name of problem area	Name of course in which area is to be taught
22. Planting, transplanting, pruning and training nursery crops	
23. Establishing and preparing a nursery site	
24. Source of planting stock	
25. Using hotbeds, cold frames, and latch houses for nursery development	
26. Cultivating and mulching trees and shrubs	
27. Identifying trees and shrubs	
28. Selecting and buying trees and shrubs	
29. Fertilizing trees and shrubs	
30. Landscaping maintenance timetable	
31. Developing landscape design	
32. Developing plot plans, construction plans, and planting plans	
33. Building terraces, pools, and ponds	

9. List training stations you plan to use in 1966-67.
(Examples: greenhouse, nursery, golf course, estates, etc.)

ORNAMENTAL HORTICULTURE INSTITUTE FORM 3

Evaluation of Ornamental Horticulture Institute

1. Rate the following Horticulture 200C instructional areas in order of value to you in starting a new program or improving your present program. Use the following rating scale: 1. highly valuable; 2. moderately valuable; 3. slightly valuable.

Value	Area	Comments
_____	Plant propagation	
_____	Greenhouse management	
_____	Nursery management	
_____	Turf management	
_____	Arboriculture	
_____	Ornamental gardening and landscaping	

2. Rate the following areas that were covered in VOTEC 459G according to their value to you in starting a new program or improving your present program. Use the same scale used in Item 1.

Value	Area	Comments
_____	Mr. Stedge's presentation	
_____	Danville field trip	
_____	Chicago field trip	
_____	Committee work on skills and problem areas	

Value	Area	Comments
____	Development of source units (term project)	
____	Handouts	
____	Corsage and floral arrangement demonstration	
	Sessions on:	
____	Course of study	
____	Teaching outlines and source units	
____	Laboratory exercises	
____	Teaching aids and references	
____	Facilities and equipment	
____	Ornamental horticulture experiences programs	

3. What were the most valuable parts of Horticulture 200?

4. What were the least valuable parts of Horticulture 200?

5. What were the most valuable parts of VOTEC 459G?

6. What were the least valuable parts of VOTEC 459G?

7. What suggestions do you have for improving the organization and conduct of the University of Illinois Ornamental Horticulture Institute?

8. Would you be willing to attend a one-day follow-up meeting of institute participants if this meeting were held in May or June 1968 and your travel expenses were paid? _______________

9. Use the space below to write any further comments on either Ornamental Horticulture 200 or VOTEC 459G.

FINAL REPORT FROM PILOT SCHOOLS
ORNAMENTAL HORTICULTURE RESEARCH PROJECT

1. Name ________________________ 2. School ______________________________

3. Number of students enrolled in separate horticulture courses taught in your school _________.

4. Number of students enrolled in regular vocational agriculture classes who received instruction in ornamental horticulture _________.

5. Number of "student periods" of instruction in ornamental horticulture provided in your school during the 1966-67 school year. A "student period" is defined as one student receiving one period of instruction at school. Multiply the number of students taught times the number of periods of instruction each student received to obtain this answer _________.

6. Of the total "student periods" of instruction reported in Item 5, how many were provided at each of the following grade levels?

9th	_______________	12th	_______________
10th	_______________	13th	_______________
11th	_______________	14th	_______________

7. Number of students involved in placement-employment programs at ornamental horticulture training stations ___________. Duration of these programs in weeks ____.

Names of training stations used. ______________________________

____

____

____

8. List major items of ornamental horticulture equipment and teaching materials purchased this year. Include laboratory equipment, books, supplies, and aids.

____

____

____

____

____

____

____

9. Changes or improvements in facilities and land laboratory. Report additions or improvements made in physical facilities or land laboratory plots.

10. Report school service or community service projects accomplished this year. Examples: Growing plants in the school, landscaping a park area, or planting trees for local residents.

11. List titles of ornamental horticulture courses or meetings taught to adults. Give titles, number of meetings, and enrollment figures.

12. Other changes made in your program. List any changes in curriculum, facilities and equipment, or teaching procedures which you made this year and were not reported elsewhere in this questionnaire.

13. Plans for 1967-68. Briefly, describe how the ornamental horticulture program in your school will be modified or changed next year (1967-68).

____

____

____

____

____

____

____

14. Rate the following factors (first, second, third, etc.) according to the influence they had in shaping your ornamental horticulture program for this year:

________________ Community need.
________________ Pressure from school board and administrators.
________________ Curriculum materials received from ornamental horticulture project.
________________ Assistance from local industry.
________________ Instruction received in Horticulture 200 last summer.
________________ Instruction received in Votec 459 last summer.
________________ Contacts and interactions with other teachers at the summer institute.
________________ My personal interest in horticulture.
________________ Extramural courses taken (list).
________________ Other factors (list).
________________ Other factors (list).

15. List the major inhibiting factors which kept you from accomplishing more in ornamental horticulture than you did in your school this year.

____________________________ ____________________________

____________________________ ____________________________

____________________________ ____________________________

____________________________ ____________________________

____________________________ ____________________________

16. What could state staffs in agricultural education at teacher-training institutions do to get more programs in vocational ornamental horticulture started in high schools of the midwest? ______________________________

____

____

____

____

____

- - - - - - - - - - - - - - - -

Return this form to Paul Hemp, 358 Education Building, Champaign, Illinois 61820, before June 1, 1968.

11/13/67pjt